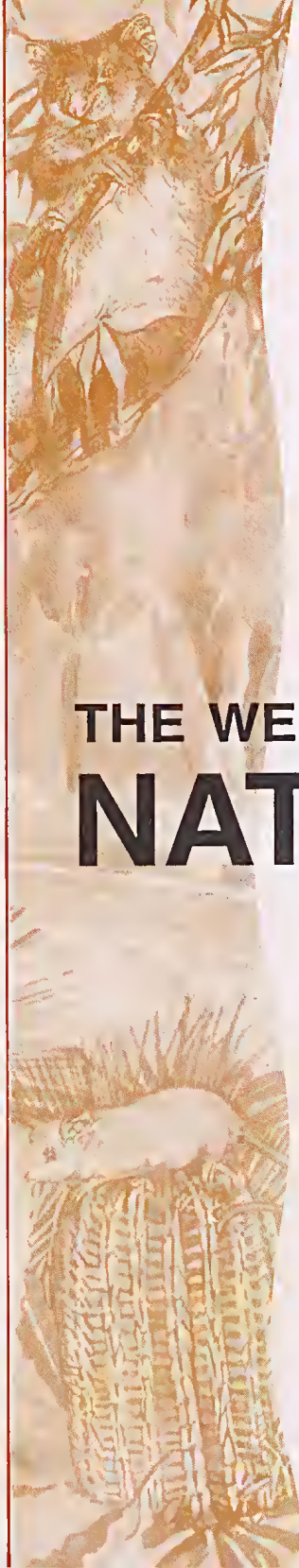

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BIRDS, MAMMALS AND FLORA OF GOOSEBERRY HILL: GENERAL INTRODUCTION

by MICHAEL BROOKER
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The natural heathland of Gooseberry Hill has persisted in its original condition since early settlement of the Darling Range, largely because the area is too steep for housing. Representative of the Helena Landform, it has unique conservational and scientific value in that it forms part of the only remaining unfragmented catena extending from the Darling Plateau (Dwellingup Landform) to the Swan Coastal Plain (Forrestfield Landform) (Churchward & McArthur 1980) and has a documented fire history since 1957 (Brooker 1998). It has therefore provided an ideal site for the study of birds and plants.

Prior to 1984, the Gooseberry Hill area had experienced a number of man-made changes. The surrounding area was first settled in 1880s when a small holding was cleared for farming (Quicke 1979). By 1891, the Zig-Zag Railway had been constructed to connect the timber concession at Canning Mills with the main line at Midland (Steele 1993). The line was closed down in 1949, after which the present-day one-way scenic drive took its place. On the study area, power-lines and a pipe-line were installed, and tracks were cut to act as firebreaks and access routes to the power-lines and pipe-line. The north-western side of the area was grazed by cattle and horses and a large, fenced section in the north-east was grazed by sheep until 1975 (Hussey 1993).

Since 1984, further tracks and a horse-trail have been constructed. Grazing was discontinued on the north-western edge of the area in 1985. Trees beneath the power-lines are regularly felled, and most of the tracks are graded once a year. Early-summer control burns on the north-west section have ceased. Recently, dieback has eliminated *Banksia grandis* from one area and probably reduced the number of *Macrozamia riedlei*.

While grazing in the past has meant that some areas are more open than was previously the case and the high fire frequency has altered vegetation structure and reduced the number of logs and dead trees, the area still

supports a diverse native flora of over 500 species, as well as an ever-increasing abundance of encroaching exotics. The diversity of habitats on the Darling Scarp, the uniqueness of many and the pressures on them from urbanizations and other alienations have previously been highlighted by Dell (1983).

In the spring of 1973, Ian Rowley started colour-banding a population of Splendid Fairy-wrens on Gooseberry Hill on the south side of the Helena River opposite the then CSIRO Wildlife Laboratory at Helena Valley. In 1984, I joined his team and, with the help of many other colleagues, most notably Graeme Chapman, Joe Leone, Lesley Brooker and Belinda Cale, expanded the study to include other bird species and a survey of the vegetation.

A full list of scientific papers and other articles relating to Gooseberry Hill is given in the Bibliography.

STUDY AREA

The study was carried out on a 120 ha area of natural heathland extending 1.5 km from a spur of the Darling Plateau to the Helena River, 200 m below (Figure 1). The area comprises steep north-facing slopes and deeply incised gullies, with numerous rock outcrops (Figure 2). The broad geological classification is Archaean; "Granite", coarse-grained and igneous rocks (Biggs et al. 1980). The soils are derived mainly from laterite, granite and dolerite and vary considerably in depth. The vegetation of the area is dominated by heath species, mainly from the families Proteaceae and Myrtaceae, with a variable overstorey of Marri *Corymbia calophylla* and Wandoo *Eucalyptus wandoo*. Balgas (grasstrees) *Xanthorrhoea preissii* are widespread and Flooded Gums *E. rudis* grow along the Helena River. Most of the area is currently "Regional Open Space" under the control of the State Planning Department and the Shire of Kalamunda.

Prior to 1984, the Australian Government Survey Office installed surveyed pegs at 100 m intervals throughout the area, providing a useful numbered reference grid. Most of the tracks and roads on Gooseberry Hill have a north-south orientation, running up and down gullies or ridges and thereby providing easy access. However, vegetation transects that were walked throughout the study ran east-west.

Wildfires were frequent (Brooker 1998), with a total of 22 fires in the 41 years from 1957 to 1998. Nine that affected Gooseberry Hill during the period 1984-1998 are shown in Table 1. They occurred in 1985, 1987, 1988 (2), 1990, 1993, 1994, 1995 and 1998.

While the great majority of observations were made on the Gooseberry Hill Study Area (hereafter simply Gooseberry Hill) (Figure 1), some data were collected at four adjoining sites:

- **Lab** refers to the CSIRO laboratory grounds (Figure 1, site 1), comprising 15 ha of citrus orchard and pasture grazed by sheep, with mature Marri trees, Wandoos and Flooded Gums but few native shrubs. Exotic trees and shrubs had been planted around the buildings;
- **Picnic Area** (Figure 1, site 5) contained vegetation similar to that on Gooseberry Hill but with more Flooded Gums and open grassland;
- **Farrant's Paddock** refers to the grazed paddocks owned by the late John Farrant (Figure 1, site 9), an area of open native woodland grazed

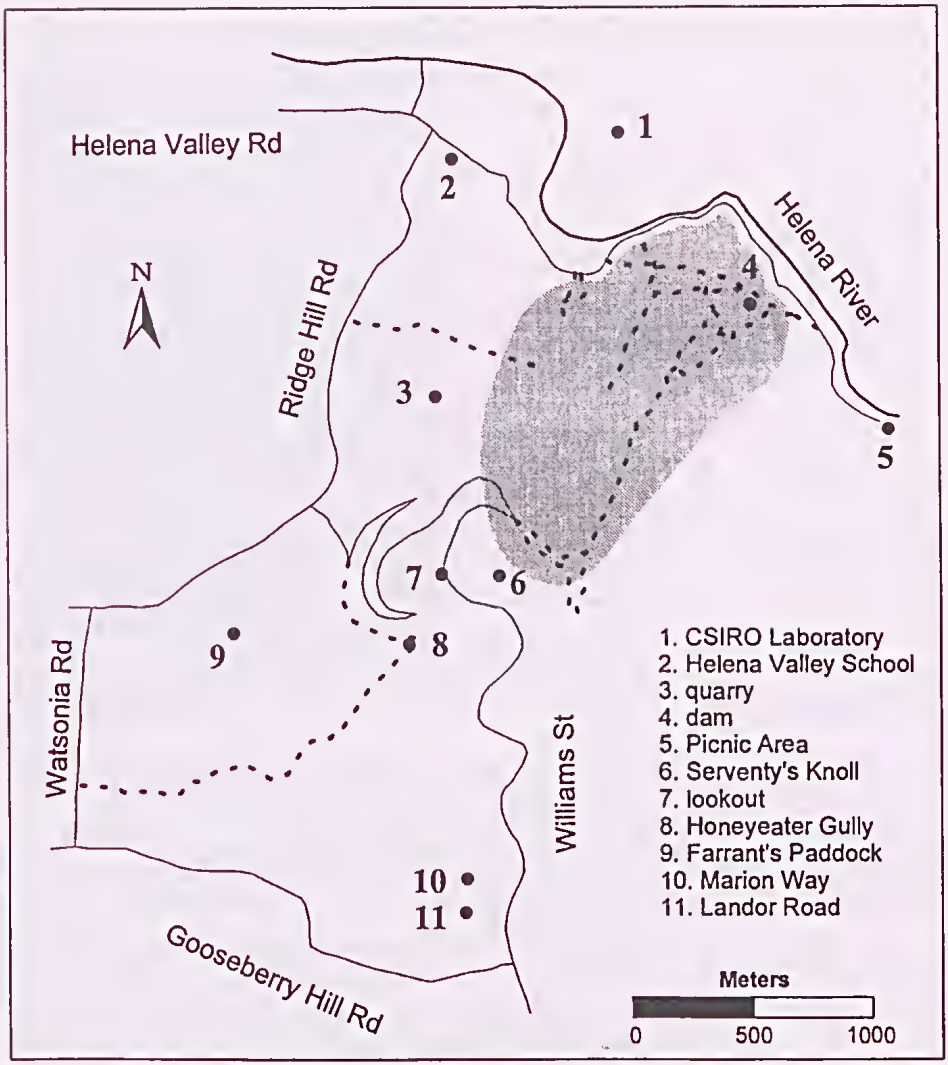


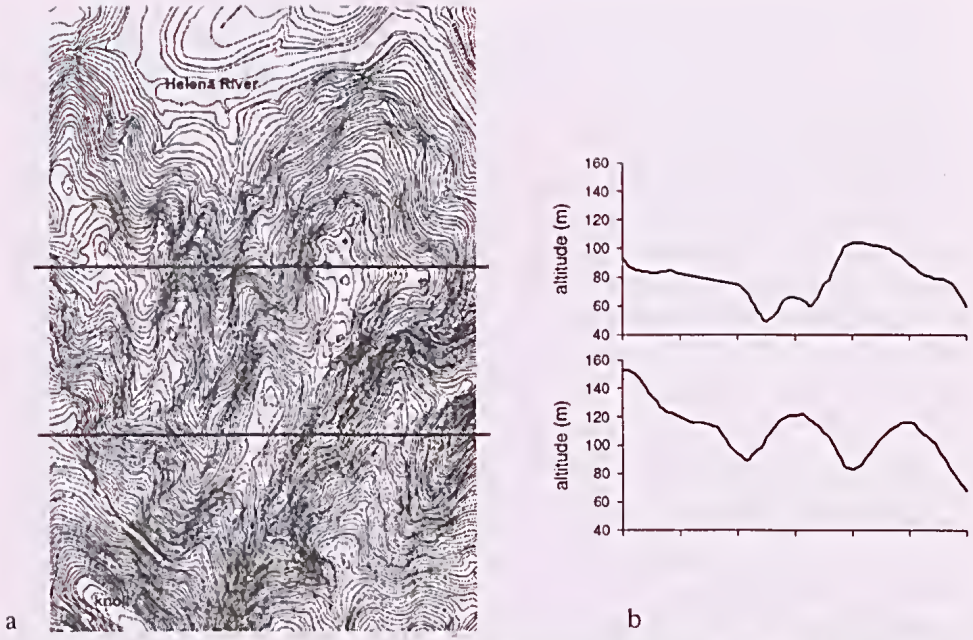
Figure 1. Map of Gooseberry Hill Study Area (shaded) and other locations mentioned in the text.

by cattle with some introduced shrubs;

- **Marion Way** refers to a nearby suburban garden (31° 57' 16" S, 116° 02' 55" E) (Figure 1, site 10), with vegetation similar to that on Gooseberry Hill but in an urban setting with more Jarrah *E. marginata* and introduced species. Weekly presence/absence records of bird species were kept, resulting in a total 64 species noted during 780 weeks in 15 years. Some of these data are presented below to supplement the Gooseberry Hill observations. Records covering the period 1984 - 1989 are given by Brooker & Brooker (1998)

Table 1. Fire history of Gooseberry Hill 1958-1998

1958	March 17	Fire over the whole of the Knoll.
1961	January 24	Fire extended from Helena River to the Knoll. Massive destruction.
1962	May 7	Fire around the whole of the Knoll.
1965	April 9	Fire to the north-east of the Knoll.
1966	February 6 April 7	Fire north of the Knoll Devastating fire from Helena Valley to the Knoll
1968	February 25-26	Fire in Helena Valley burnt to Zig Zag Road
1969	January 23	Extensive fire from west crossed Ocean View Parade and burnt part of the Knoll
1972	March 31-April 2	Extensive fire from Helena Valley and Kalamunda National Park burnt most of eastern and northern part of the Knoll.
1974	December 16	Fire deliberately lit along valley roadside. Very little wind, so fire spread was gentle.
1976	December 14	Fire ran up the centre valley to the Knoll.
1977	December 12	Fire burnt that portion of study area not burnt in 1976 and reburnt the western valley.
1978	December 27	A fire from the quarry area burnt right up to the study area and burnt the western valley for the third year in a row.
1981	November 11	Fire from the east. Very slow burn extinguished by rain in the evening.
1985	January 30	Major hot fire started in Helena River. Burnt study area (except southern edge) and about 1 km east and west of it.
1987	February 21	Fire started c. 1530 h south-west of study area. Burnt southern edge and central and western parts of study area
1988	April 3	Minor hot fire started c. 1540 h north-east of study area and burnt eastern edge.
	April 14	A separate fire burnt an extensive area to the east of the study area.
1990	January 3	A small, hot fire from the quarry area burnt as far as the south-western edge of the study area
1993	December 22, 24, 25	Three small fires: the first started on southern edge; the other two were flare-ups. A small area of the Knoll was burnt.
1994	February 6	Major hot fire. Burnt most of the study area except southern edge. Extensive areas to the east and west of the study area also were burnt.
1995	January 24	Small hot fire started c. 2330 h to west of study area. Study area not burnt.
1998	November 1	Hot controlled burn along southern edge (firebreak)



a b

Figure 2. (a) Two metre contour plot of Gooseberry Hill Study Area and (b) two cross-sectional profiles of altitude.

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BIRDS OF GOOSEBERRY HILL

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ABSTRACT

Biological information is presented for 96 species of birds found on or near the Darling Scarp on the southern side of Helena Valley, Western Australia between 1984 and 1998. I have endeavoured to relate the distribution and abundance of the birds to habitat, season and the occurrence of wildfire. However, interpretation of the observed spatial and temporal patterns of occurrence for many species, be they sedentary, migratory or nomadic, was made more difficult by the high fire frequency, even with 15 years data available for comparison.

Nevertheless, some conclusions can be made. I have been able to identify a suite of sedentary species that seem able to withstand a very high fire frequency. While some species such as Western, Yellow-rumped and Inland Thornbills appear to have declined, their drop in numbers has not been nearly as great as for Splendid Fairy-wrens, which declined by 80%. The long-term persistence of fairy-wrens in this area now relies on the permanent connection of the heathland to undisturbed, larger areas of similar habitat and the same probably applies to the other heath-dwelling species. An additional threat to the long-term survival of such species is the continued increase of introduced plants; eg. the choking of preferred nesting sites such as gullies by watsonias.

While the major tree species (Marris and Wandoos) continue to regenerate after fires, the gradual loss of mature and dead trees to fire may be detrimental to those bird species that rely on hollows for breeding and roosting. A prime example is the Owlet Nightjar, which is now locally extinct.

Gooseberry Hill and surrounding areas have considerable intrinsic and extrinsic conservation value. We now have a long-term and detailed baseline inventory of faunal and floral information, besides which the area forms the only remaining connection between the last large remnant of the Ridge Hill Shelf Landform and the Scarp, where it adjoins the forests of Kalamunda National Park.

METHODS

In this paper I document the results of bird observations made on Gooseberry Hill and surrounding areas since 1984. Over fifteen years (1984 - 1998) a large body of bird breeding data was accumulated, most notably for cuckoos, thornbills, scrubwrens, woodswallows

and robins, as well as wrens. The depth of study varied considerably between species and over time, ranging from the colour-banding of all adults and nestlings of some species, to a simple record of presence/absence for other species (Table 2). Accordingly, the effort expended on the study (number of hours of observation) also varied between and within years (Figure 3). The impact of these differences is taken into account when discussing differences in the occurrence of species. Naturally, much more information could be obtained from species with large numbers of individually colour-banded birds (Table 3). Morphological measurements (Appendix 1) were taken from birds that were mist-netted. Egg measurements for 14 species are shown in Appendix 2.

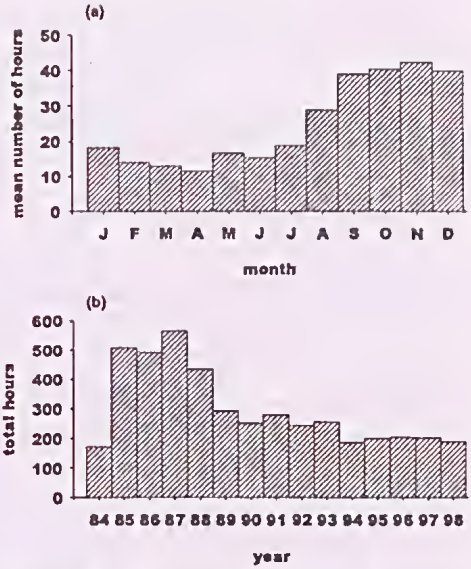

Figure 3. Amount of effort expended according to (a) month and (b) year.

The late Dr. Dom Serventy kept records of birds at his residence, the Knoll (Figure 1, site 6) in the form of an unpublished, annotated list for the period 1957 - 1974, and in notebooks held by the WA Museum. I make reference to these observations, where relevant.

Table 2. Types of bird observations made

Species	Period	Type of observations
Splendid Fairy-wren	1973-1989	Adults and nestlings colour-banded, nests located, censused January, July and September
	1990-1998	Censused in spring, some adults and nestlings colour-banded
Western Thornbill	1984	Some adults and nestlings colour-banded, most nests found
	1985-1989	Adults and nestlings colour-banded, nests found
	1990-1995	Some adults and nestlings colour-banded, some nests found, censused in spring.
Yellow-rumped Thornbill Scarlet Robin	1985-1998	A few birds colour-banded, nests found, breeding density estimated
Cuckoos	1984-1998	Nestlings and some adults colour-banded Location, time and type of call recorded
Migrants and Nomads	1984-1998	Location recorded
Raptors	1984-1998	Time, location and number recorded
Other species	1984-1998	Presence/absence recorded each visit Details recorded for rare and vagrant species

Table 3. Numbers of birds banded.

Species	Colour banded		Metal Banded Only		Total
	Adults	Young	Adults	Young	
Fan-tailed Cuckoo	5	3	-	-	8
Horsfield's Bronze-Cuckoo	8	62	-	9	79
Shining Bronze-Cuckoo	9	34	1	-	44
Splendid Fairy-wren	277	1431	-	-	1708
Red-winged Fairy-wren	2	9	-	-	11
Striated Pardalote	10	-	8	-	18
White-browed Scrubwren	43	33	6	-	82
Weebill	10	3	-	-	13
Western Gerygone	9	2	-	3	14
Inland Thornbill	17	13	-	-	30
Western Thornbill	222	319	10	90	641
Yellow-rumped Thornbill	48	101	11	37	197
Brown Honeyeater	-	-	161	69	230
Tawny-crowned Honeyeater	23	15	-	20	58
Western Spinebill	60	2	19	-	81
Scarlet Robin	12	16	-	-	28
Red-capped Robin	9	2	-	-	11
Golden Whistler	3	-	3	-	6
Rufous Whistler	22	2	-	-	24
Grey Shrike-thrush	1	3	-	-	4
Grey Fantail	9	-	5	2	16
Willie Wagtail	4	2	-	-	6
Dusky Woodswallow	21	29	-	-	50
Grey Butcherbird	4	3	-	-	7
Red-browed Finch	5	3	-	4	12
Mistletoebird	-	-	6	-	6
Silvereye	-	-	192	78	270
	833	2087	422	312	3654

SPECIES ACCOUNTS

Emu *Dromaius novaehollandiae*

One Emu was recorded on Gooseberry Hill on 17 December 1985 (June Butcher pers. comm.).

Australian Shelduck *Tadorna tadornoides*

Seen occasionally along Helena River from July to September.

Australian Wood Duck *Chenonetta jubata*

Flocks of up to 50 seen on the dam at the Lab. Pairs nested on Gooseberry Hill and in the Lab grounds in hollows in Wandoo and Marri trees. Newly hatched ducklings were seen on 1 October 1985 (8); 15 October 1989 (6); 2 September 1992, 23 September 1993 (8) and 21 August 1995 (6).

Pacific Black Duck *Anas superciliosa*
Common along the Helena River in winter; some pairs nested on the ground under heath on Gooseberry Hill; one such nest was 1.5 km from the river. Ducklings were seen from August to October.

Darter *Anhinga melanogaster*
Occasionally seen flying along the Helena River.

Little Pied Cormorant *Phalacrocorax melanoleucos*
Occasionally seen along Helena River.

White-faced Heron *Egretta novaehollandiae*
Seen often along the Helena River and in the Lab grounds where a pair nested in 1986.

White-necked Heron *Ardea pacifica*
One record on the river, 19 July 1985.

Great Egret *Ardea alba*
One individual seen on Helena River on 22 January 1990.

Nankeen Night Heron *Nycticorax caledonicus*
A juvenile was seen near a pool in the Helena River on 2 March 1993.

Australian White Ibis *Threskiornis molucca*
Seen infrequently along Helena River and on the dam at the Lab.

Straw-necked Ibis *Threskiornis spinicollis*
Several were seen in October 1987.

Black-shouldered Kite *Elanus axillaris*
Seen in all months of the year except March. Most often seen from July to October (63% records, n = 46). Only 20% of all records were actually on Gooseberry Hill, the rest were made in cleared habitat, especially that along Ridge Hill Road.

Square-tailed Kite *Lophoictinia isura*
Recorded on 34 occasions, mainly between August and November, with only two records since 1994. Thirty-two of the records were of single birds. At 1020 h on 18 August 1987, a Square-tailed Kite, flying at about 100 m above ground, was harried by two Australian Ravens. One Raven grasped the tip of the Kite's left wing and the two started to circle. The second Raven then landed on the Kite's back and all three tumbled toward the ground for several seconds before parting company.

Whistling Kite *Haliastur sphenurus*
No records of Whistling Kites were made during my survey period. Serventy reports that they were "not often seen" during his observations from 1957 to 1974; Mawson and Massam (1995) give one record (January 1992) for Forrestfield for the period 1991 - 1992.

Brown Goshawk *Accipiter fasciatus*
During 15 years, Brown Goshawks were observed on 89 occasions, with another 36 sightings which were either Brown Goshawks or Collared Sparrowhawks. Forty-seven of the Brown Goshawk sightings (53%) were made in October and November.

One nest was found in a tall Marri near the Helena River in September 1986. An unsuccessful attack on a Laughing Turtle-Dove was observed in October 1987.

Collared Sparrowhawk *Accipiter cirrhocephalus*
Collared Sparrowhawks were recorded less frequently (n = 36) than Brown Goshawks, with 78% of sightings made between September and January.

Individuals were seen feeding on Brown Honeyeaters on two occasions.

In February 1997, a sparrowhawk and an adult Red Wattlebird took it in turns to chase one another over a 15 minute period. When the raptor perched, the wattlebird taunted it. Subsequently, a wattlebird nest with large nestlings was found nearby. In January 1999, a juvenile sparrowhawk unsuccessfully chased some Australian Ringnecks and a fledgling Red Wattlebird in the same area for 20 m. A female was observed plucking a Spotted Turtle-Dove on 14 May 1999.

Wedge-tailed Eagle *Aquila audax*

Seen occasionally on Gooseberry Hill (108 occasions over 15 years). Seen most often in summer to early autumn (December - March); least often in spring (September - November). Most individuals that could be aged (77% of 144 sightings) were dark adults, 6+ years of age (Ridpath & Brooker 1986).

Little Eagle *Hieraaetus morphnoides*

Little Eagles were the most frequently observed raptor, seen on 158 occasions (c.f. Dell 1971). Most records (63%) were from September to November. Often the bird or birds were being harried by other species, mainly Australian Ravens (52%), Australian Magpies (34%) or both (7%). Other species included a Peregrine Falcon (twice), Nankeen Kestrel (once), male White-winged Triller (once) and a Dusky Woodswallow (4 times).

Fledglings were recorded in January 1988, December 1988 and October 1997. One female, who was missing most of the flight feathers on her right wing, was seen over Gooseberry Hill on 11 occasions from 30 August 1987 to 12 November 1987.

Brown Falcon *Falco berigora*

Not common. Single birds recorded on 25 occasions in 15 years, with records in all months of the year except March. Serventy made only two records, in July 1964 and June 1972. Fledglings were seen in Scott Street, Helena Valley in November 1985.

Australian Hobby *Falco longipennis*

There were no confirmed sightings of this species, although five sightings of distant birds were either Australian Hobbys or Peregrine Falcons. Serventy saw two (June 1965 and November 1971) during the period 1957 - 1974 and Mawson and Massam (1995) recorded it at Forrestfield (c. 6 km south-west of Gooseberry Hill) in September and October each year from 1990 to 1992.

Peregrine Falcon *Falco peregrinus*

Peregrines Falcons were recorded on 42 occasions spread throughout the year. They were seen to harry Little Eagles and Wedge-tailed Eagles. Observed eating or chasing Rock Doves (3), Laughing Turtle-Dove (1) and a Fan-tailed Cuckoo (1).

Nankeen Kestrel *Falco cenchroides*

One or more kestrels were recorded on 140 occasions, most often (74%) from September to December, with only one sighting in March, one in April and two in May. Ninety-two percent of sightings were of single birds. A juvenile male netted on 7 May 1986 was marked with a wing window. He was seen again on four occasions, the latest on 31 December 1986.

Spotless Crake *Porzana tabuensis*

One individual was found dead on Gooseberry Hill Rd on 18 August 1987.

Little Button-quail *Turnix velox*

Little Button-quail were present on Gooseberry Hill in considerable numbers between October 1985 and January 1986, when they nested on the area that had been burnt the previous January. A nest with four eggs was found on 18 October 1985, three of which hatched on 2 December.

Painted Button-quail *Turnix varia*

Observed throughout Gooseberry Hill, mainly from November to March; no records in April or June. Painted Button-quails were most abundant in the years following fire. They appeared to decline as the vegetation recovered, becoming rare by 1992, 8 years after the 1985 fire. Serventy found a nest in October 1964. During this study, breeding was observed on 20 December 1985 (2 runners) and 9 December 1988 (2 eggs).

Rock Dove *Columba livia*

Seen in cleared country along the Helena River and, very occasionally, flying over heathland habitat. They nested each year in a large dead Wandoo tree near the Helena Valley Primary School and, in 1998, in a large dead Marri on the northern edge of Gooseberry Hill.

Laughing Turtle-Dove *Streptopelia senegalensis*

Present in suburbia and occasionally seen in heathland, mainly from September to January. During the study period, the numbers seen on Gooseberry Hill (Figure 4) and at Marion Way (Figure 5) have declined, while the numbers of Spotted Turtle-Dove have increased. Eleven breeding records were made, six on Gooseberry Hill and five at the Lab. Nests with eggs have been recorded from 26 August to 17 January,

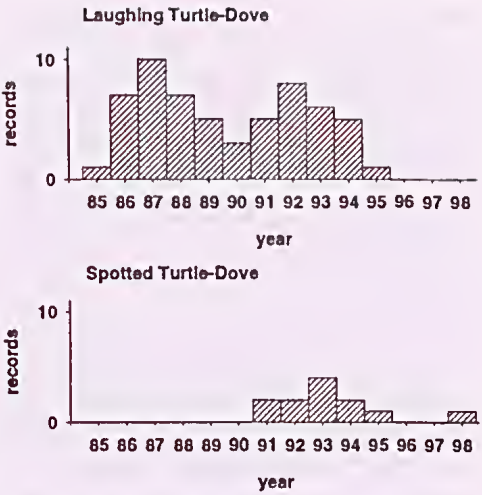

Figure 4. Number of records of Laughing and Spotted Turtle-Doves on Gooseberry Hill 1985-1998.

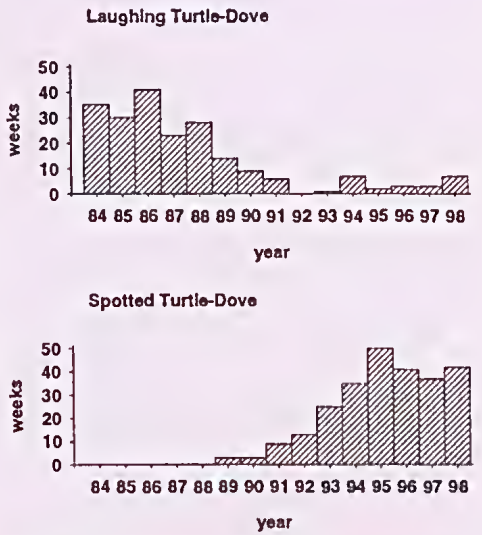

Figure 5. Numbers of Laughing and Spotted Turtle-Doves at Marion Way.

built in native and exotic trees and shrubs (Appendix 3).

Spotted Turtle-Dove *Streptopelia chinensis*

There were no definite sightings of Spotted Turtle-Doves from 1984 to

1989. Since then, the number of observations has increased, while those for Laughing Turtle-Doves have declined (Figures 4 and 5). Spotted Turtle-Doves are now commonly seen at Marion Way and the Lab and occasionally on the northern edge of Gooseberry Hill. A nest with eggs was found at the Lab on 11 January 1995 in an exotic shrub.

The relative frequencies of the two *Streptopelia* spp. in this area appear to fluctuate - during the period 1957 to 1974, Serventy saw more Spotted than Laughing Turtle-Doves.

Common Bronzewing *Phaps chalcoptera*

Recorded in all years, with no evidence of increased abundance on burnt areas following fires in 1985, 1987 or 1994. One nest contained two nestlings on 1 November 1984, another was being built on 2 November 1998 and a fledgling was recorded on 5 December 1991.

Red-tailed Black-Cockatoo *Calyptorhynchus banksii*

Despite being reasonably common in nearby Jarrah forest, Red-tailed Black-Cockatoos were encountered on only four occasions on Gooseberry Hill, once in January and October and twice in November.

Short-billed Black-Cockatoo *Calyptorhynchus latirostris*

Some birds seen in all months of the year on Gooseberry Hill. Short-billed Black-Cockatoos were most frequently recorded from July to October, with very few records for May, November and December. Weekly records from Marion Way showed a similar trend, with birds arriving in January and becoming less numerous from July onwards; only one

Figure 6. Records of Short-billed Black-Cockatoos at Marion Way, 1984-1998.

record for the period October to December (Figure 6).

Observed feeding in heath habitat on *Hakea* spp. from April to August. One group moved through Gooseberry Hill in early September 1988, demolishing the mantles of recently dead *Xanthorrhoea preissii*. On another occasion in July 1986, bark was stripped from a patch of Marri saplings.

Long-billed Black-Cockatoo *Calyptorhynchus baudinii*

Recorded in a mixed flock with Short-billed Black-Cockatoos at the Lab in April (1 record), May (1), June (1), August (4) and February (2) (identifications confirmed by D. Saunders and J. Ingram) and at Marion Way in June (1) and July (1).

Galah *Cacatua roseicapilla*

While Galahs were not observed feeding on Gooseberry Hill, at least five pairs nested there (Figure 7). Of 16 nest trees found in the whole area, four were Marris, two were Flooded Gums and 10 were Wandoos.

Long-billed Corella *Cacatua* sp.

First recorded in the area when a flock of about 40 flew over the Lab on 13 July 1991. Another flock was recorded during 1992 (Aug) and two during 1993 (Aug, Nov). Since 1994, individuals and small groups of birds

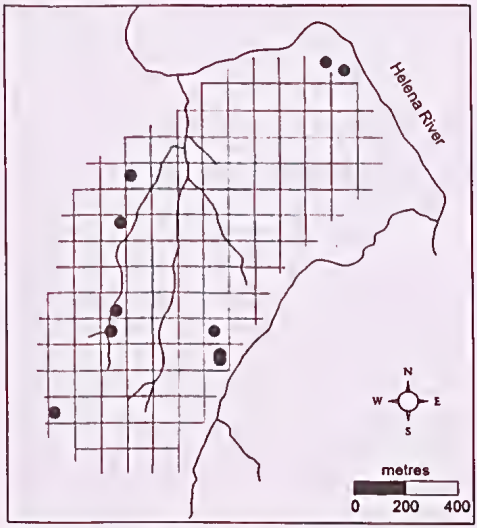

Figure 7. Locations of nest trees used by Galahs on Gooseberry Hill, 1984-1998.

have been regularly recorded flying up and down Helena Valley from mid-June to early December, presumably commuting between nesting and feeding areas.

Sulphur-crested Cockatoo *Cacatua galerita*

Single bird or pairs were recorded on six occasions (23 Nov 1985, 1 Nov 1986, 16 Sep 1987, 1 Nov 1987, 3 Dec 1988, 30 Nov 1989). None have been recorded since.

Rainbow Lorikeet *Trichoglossus haematodus*

Serventy gives an early record for 11 April 1972 at the Lab. During the period 1984-1998 they were recorded on only two occasions on Gooseberry Hill, in December 1991 and June 1998. More recently, Rainbow Lorikeets were recorded at Marion Way in two weeks of September 1999 and during two four-week periods (February – mid-March, August – early September) of 2000.

Purple-crowned Lorikeet *Glossopsitta porphyrocephala*

Flocks of Purple-crowned Lorikeets were occasionally recorded flying over Gooseberry Hill. There are records for all months of the year except May and June. They were most numerous in October and November 1992 and in September and October 1995, when they fed on flowering eucalypts (Flooded Gums and exotics) at the Lab. The 1992 occurrences coincided with those recorded by Mawson and Massam (1995) at their site at Forrestfield, about 6 km south-west of Gooseberry Hill.

Australian Ringneck *Barnardius zonarius*

Common along the southern edge of Gooseberry Hill adjacent to suburbia and in the farmland and riverine habitats on the northern side, throughout the year. Few records from the central area of Gooseberry Hill, except from May to October when small numbers nested in the Wandoos there. Serventy's comment "unusual at The Knoll" suggests that numbers may have increased in suburbia since the 1970s.

Australian Ringnecks were observed feeding on Marri seeds and flowers, *Petrophile biloba* seeds, Balga flowers and seeds, wild oats, *Avena* sp. seeds, *Helichrysum lindleyi* flowers, *Watsonia* sp. flowers, scale insects and green seeds on *Eucalyptus rudis* and White Cedar *Melia azedarach* berries at the Lab.

Western Rosella *Platycercus icterotis*

Only 40 records of Western Rosellas were made on Gooseberry Hill in 15 years. They were seen most often in November (7), least often in April (0); and none have been seen on Gooseberry Hill since 1993. At least one pair was resident at the Lab; a flock of 13 was sighted there in May 1987. In 1997, a

pair nested in a hole under the eaves of an old cottage at the Lab. Seen feeding on *Hakea trifurcata* seeds in May and February and on *Watsonia* flowers in October.

Red-capped Parrot *Purpureicephalus spurius*

Present throughout the year on Gooseberry Hill and, unlike Australian Ringnecks, distributed throughout the area. Nests found from August onwards; fledglings seen from October to December.

Recorded feeding on Marri seeds and, less frequently, the dry seeds of *Acacia pulchella, Petrophile biloba, Isopogon dubius, Grevillea endlicheriana, G. pilulifera, Xanthorrhoea preissii*, the green seeds of *Daviesia horrida* and *Erodium* sp. and on the flowers of *Watsonia* sp.

Budgerigar *Melopsittacus undulatus*

A flock of about 20 birds flew up the main gully on 15 November 1984. (See also Aviary Escapees)

Elegant Parrot *Neophema elegans*

There was a regular within-year pattern of occurrence by Elegant Parrots, with marked between-year variation. Most sightings (89%, n = 147) were made from September to January inclusive, with no records for March, April or July. The few observations in May and June were of birds flying over the area. No Elegant Parrots were seen during 1984 but they were regularly observed in the spring and early-summer of the following seven years; i.e. after the major fire in 1985 and minor fires of 1987 and 1988. Fledglings were seen in November 1985, 1986, 1988 and 1989. There have been only nine records since 1993 (none for 1996 or 1998) and no further evidence of nesting on the area. The ready availabililty of abundant grass seed such as *Stipa macalpinei* produced after fire, is probably an important factor in determining whether Elegant Parrots will breed on Gooseberry Hill.

Pallid Cuckoo *Cuculus pallidus*

Calling males were recorded from June to November, with most records (71%) in August and September. The duration and timing of their visits varied considerably between years (Figure 8). No adults were seen in December, January or February, and only one record each for April and May, of silent birds. Pallid Cuckoos were usually found in the cleared farmland, along the Helena River and on the northern fringe of Gooseberry Hill (86% of records). Most records on Gooseberry Hill proper were made during 1986 - 1987, a time when the recently burnt habitat probably provided feeding rather than breeding opportunities.

The only evidence of breeding was at the Lab, where a newly fledged cuckoo was fed by New Holland Honeyeaters on 26 October 1988 and an older fledgling was seen every day from 1 December 1997 to 24 December 1997, feeding on a White Cedar *Melia azedarach* heavily infested with caterpillars, which were probably the larvae of the Cedar Moth

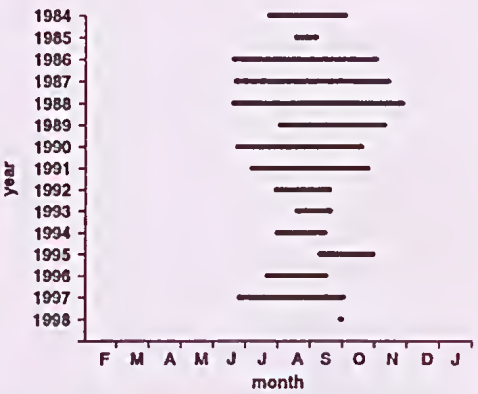

Figure 8. Length of stay of Pallid Cuckoos at Gooseberry Hill, 1984-1998.

Leptocneria reducta. Ian Rowley (pers. comm.) recorded a fledgling at Guildford on 23 December 1994.

A fledgling was fed by White-breasted Robins *Eopsaltria georgiana* along the Helena River in November 1999.

Fan-tailed Cuckoo *Cacomantis flabelliformis*

Fan-tailed Cuckoos were regular breeding migrants to Gooseberry Hill. Their time of arrival (earliest call) varied from 1 May in 1990 to 4 July in 1994 (median 3 June, n = 15) (Figure 9). Last calls of the season varied from 7 September in 1996 to 2 November in 1998 (median 17 October, n = 15). Juveniles were present on the area until 1 February.

Calling in the riverine habitat was heard more often in May to mid-June and October, than in the intervening months. Three calls were recognized - the "trill", the mournful rising "whistle" and the "chirreee" (Marchant & Hohn 1980; Brooker & Brooker 1994b). The "trill" was the call heard most often (88%), followed by the "whistle" (8%) and the "chirreee" (4%) (n = 395). There were no obvious differences between months in the frequencies of the three calls.

Parasitism was recorded in 12 White-browed Scrubwren nests (cuckoo eggs estimated to have been laid September 1985, August and October 1986, July and August 1987, July and August 1988) and three Inland Thornbills nests (cuckoo eggs estimated laid July and August 1987).

In one Inland Thornbill nest (8702), the cuckoo egg was laid before the clutch was complete; the incubation period was 15 d measured from the time of laying and 13 d from clutch completion (i.e. presumed start of incubation); the cuckoo chick had ejected two unhatched thornbill eggs before it was 23 - 40 h old; the nestling period was 18 - 19 d. Growth curves for body mass and folded wing length of one nestling are shown in Figure 10.

Horsfield's Bronze-Cuckoo *Chrysococcyx basalis*

Horsfield's Bronze-Cuckoo was a common breeding migrant to Gooseberry Hill in the 1980s, but has been rare to absent in the 7 years since 1991, a period when the major host in this area (Splendid Fairy-Wren) was in considerable decline. Arrival and

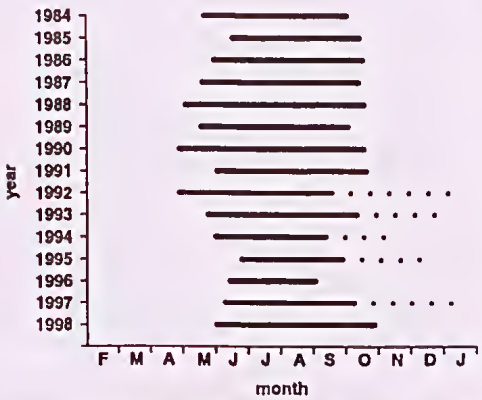

Figure 9. Length of stay of Fan-tailed Cuckoos at Gooseberry Hill, 1984-1998 (dots on right indicate juveniles).

Figure 10. Body mass and folded wing length of a nestling Fan-tailed Cuckoo (n = 1).

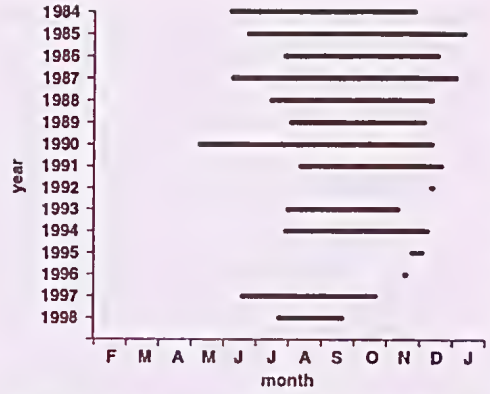

Figure 11. Length of stay of Horsfield's Bronze-Cuckoos at Gooseberry Hill, 1984-1998.

departure dates (observations based on call) are shown in Figure 11.

Three types of call (Brooker & Brooker 1994b; Higgins 1999) were recorded, the descending "phew", the "churr" and a rare sparrowlike "chirrup" (called "strill" by Dell 1971).

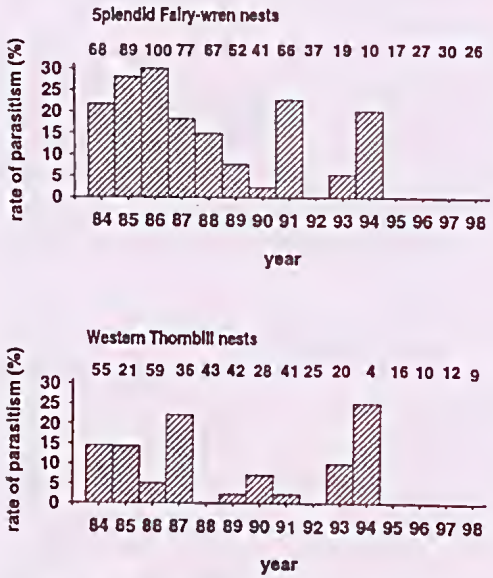

Figure 12. Rates of parasitism by Horsfield's Bronze-Cuckoos of Splendid Fairy-wrens and Western Thornbills, 1984-1998 (total nests across top).

Horsfield's Bronze-Cuckoos parasitized Splendid Fairy-wrens, Western Thornbills and Scarlet Robins on Gooseberry Hill (Brooker & Brooker 1986, 1988, 1989a, b, 1992). The proportions of nests parasitized since 1984 are shown in Figure 12. The incubation period of the cuckoo egg varied: 12 d in Splendid Fairy-wren nests (n = 10); > 13 d in a Western Thornbill nest (n = 1). The cuckoo chick had usually ejected any host eggs or young before it was 48 h old. Nestling period in nests of Splendid Fairy-wrens was 16 - 17 d (n = 10) and in nests of Western Thornbills 20 d (n = 1). A growth curve for nestling Horsfield's Bronze-Cuckoos is given by Brooker & Brooker (1989).

Although a number of adults and nestlings were colour-banded (Table 3), none were resighted in subsequent years. However it is possible that banded birds may have been missed as their feathered tarsi and tendency to present a silhouette when perched, made it difficult to check whether or not a bird was banded.

Shining Bronze-Cuckoo *Chrysococcyx lucidus*

A regular breeding migrant to

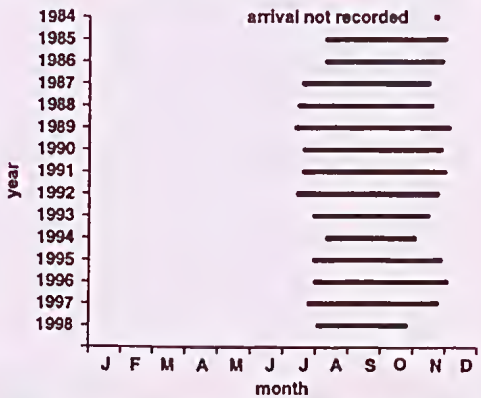

Figure 13. Length of stay of Shining Bronze-Cuckoos at Gooseberry Hill, 1984-1998.

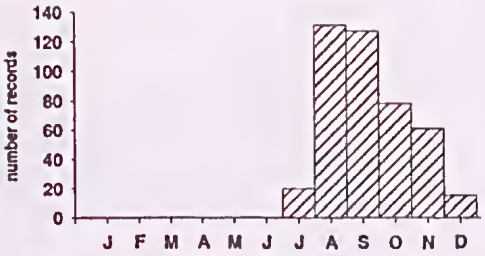

Figure 14. Frequency of calling Shining Bronze-Cuckoos at Gooseberry Hill, 1985-1998.

Gooseberry Hill from mid-July to early December (Figure 13). The median date of arrival (from observations based on call) was 4 August (n = 14); departure 28 November (n = 15). Equivalent dates for Woorooloo (25 km north-east of Gooseberry Hill) were 16 August (arrival) and 24 November (departure) (Sedgwick 1956). On Gooseberry Hill, juveniles were recorded until early January. Shining Bronze-Cuckoos called most frequently in August and September (Figure 14).

Both Yellow-rumped and Western Thornbills were parasitized throughout Gooseberry Hill (Brooker & Brooker 1986, 1988, 1989a,b, 1992), the former also in cleared areas such as Farrant's Paddock (Figure 15). Two nests of Inland Thornbills in Farrant's Paddock also were parasitized.

The incubation period of the cuckoo egg was 14 - 15 d in Yellow-rumped Thornbill nests (n = 4). The cuckoo chick had usually ejected any host eggs or young before it was 96 h old, sometimes before 48 h. Nestling period in nests of Yellow-rumped Thornbills was 18 - 23 d (n = 4) and in nests of Western Thornbills 22 d (n = 1). A growth curve for nestling Shining Bronze-Cuckoos is given by Brooker & Brooker (1989).

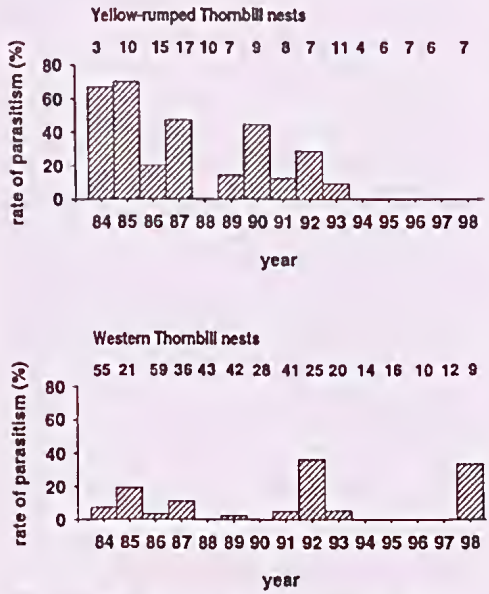

Figure 15. Rates of parasitism of Yellow-rumped Thornbills and Western Thornbills by Shining Bronze-Cuckoos at Gooseberry Hill, 1984-1998 (total nests across top).

Southern Boobook *Ninox novaeseelandiae*

Single birds and pairs seen occasionally on Gooseberry Hill (15 records) in all months except January and April. At Marion Way some were present throughout the year (Figure 16). Most of these records (91%) were based on call. All sightings were of birds roosting in the garden in summer when fledglings were present. Fledglings appeared at

Figure 16. Number of weeks in which Southern Boobooks were recorded at Marion Way, 1984-1998.

Marion Way from late December to early January in 1985, 1986, 1987, 1990, 1993 and 1995, which indicates that breeding was successful in 6 of 15 years (40%).

Barn Owl *Tyto alba*

Heard occasionally at Lab (Nov 1985, Feb 1995) and at Marion Way (Dec 1984, Jan 1985, Feb 1985, Nov 1985). Three small nestlings were found when a large dead Marri fell in Clayton Road, Helena Valley on 18 June 1996.

Tawny Frogmouth *Podargus strigoides*

Present in all months of the year on Gooseberry Hill and at Marion Way (Figure 17). Unlike Southern Boobooks, most of the records for Marion Way (85%) were based on sightings rather than call. No calling was recorded from May to mid-August. Tawny Frogmouths have a long breeding season, from 29 August (earliest, sitting on eggs) to 21 February (latest, 2 young fledged). The latter were seen with their parents until 19 April 1998. The combined length of incubation and nestling periods was 57 days, which is within the range (54-60 days) given by Körtner and Geiser (1999).

Another nest in the same area was built by 15 August; the female commenced sitting on 29 August; one chick fledged on 24 October and the second on 26 October 1998; both were still present on 21 November. The family of four were again perched in the nest tree on 24 March 1999. A 2 m high nest site in a Wandoo tree was used in 1988 and 1990. One individual was fitted with a metal band on its right leg on 23 March 1987. A bird of this description was re-sighted in the same area on 3 February 1991 and again, with a fledgling, on 22 November 1991. Although the band number was not verified, it is highly likely that these sighting refer to the same individual.

Figure 17. Number of weeks in which Tawny Frogmouths were recorded on Gooseberry Hill, 1984-1998.

Spotted Nightjar *Eurostopodus argus*

A Spotted Nightjar was found dead on the Zig Zag Road on 5 April 1991. Another rose from the ground in a gully on Gooseberry Hill on 10 April 1995. Serventy flushed a bird near the Zig Zag Road on 2 June 1962.

These observations are consistent with the status category "casual", given by Johnstone and Storr (1999) for the Darling Range.

Australian Owlet-nightjar *Aegotheles cristatus*

Between November 1984 and June 1988 Australian Owlet-nightjars were heard on 15 occasions, all on the southern half of Gooseberry Hill, mostly from October to February (11 of 15 records). One bird was observed at the entrance to a hollow in a Wandoo tree on 12 December 1984 and one dark grey individual was found dead on the Zig Zag Road on 11 November 1987. Since 1988 there have been no further records.

Fork-tailed Swift *Apus pacificus*

Two flocks, each of about 20 birds, were recorded on 1 April 1990 and 2 March 1996. These were times when Fork-tailed Swifts were recorded elsewhere in

the Perth area (WA Bird Notes 53, 54 and 78).

Laughing Kookaburra *Dacelo novaeguineae*

Common along the northern and southern fringes of Gooseberry Hill (64% of records) but seen occasionally throughout the area in all months.

The earliest fledglings were recorded on 8 October; latest on 11 February (n = 11). A fledgling banded in February 1992 was found 33 months later, drowned in a pool 1.2 km from the banding site. A juvenile banded in February 1995 was rescued 69 months later from a swimming pool about 400 m from the banding site. An adult banded in December 1984 was resighted on several occasions at the banding site; the last occasion 70 months after banding.

I mist-netted an adult at a Kalamunda residence on 21 December 1988. It had become a nuisance by constantly striking a large window and there was a danger that the two large dogs inside the house would smash the glass as they tried to attack the kookaburra. I transported the bird to Wundowie and released it. However, six weeks later it had returned, covering a straight line distance of 30 km. Although not banded, I could be certain that it was the same bird because it attacked the window in the same fashion, had the same deformed lower bill and was very wary of mist-nets. It subsequently disappeared.

Sacred Kingfisher *Todiramphus sanctus*

Sacred Kingfishers were regular breeding migrants to Gooseberry Hill. Arrivals and departures from 1984 to 1998 are shown in Figure 18. The median date of arrival was 20 September (n = 14),

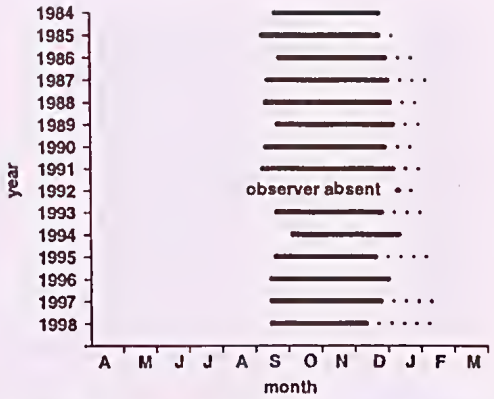

Figure 18. Length of stay of adult Sacred Kingfishers at Gooseberry Hill, 1984-1998 (dotted lines indicate presence of juveniles).

somewhat earlier than that reported for Wooroolo (12 October, n = 3) by Sedgwick (1956). The median departure date for adults was 5 January (n = 15). The first sightings of Sacred Kingfishers each year were always in or near the Helena River. Most adults had usually departed by mid-January; adults at late nests appeared to leave their young soon after they had fledged. Juveniles were present until mid-February, often congregating around swimming pools and dams before departure. An estimated 5 to 6 pairs nested on Gooseberry Hill (114 ha) with a further 2 to 3 pairs in the adjoining riverine habitat.

Nests were found in Marri and Wandoo trees. At least two regularly-used nesting trees were burnt down during the study.

One adult colour-banded on 20 October 1984 was resighted in the same area on 17 October 1985. A dead juvenile was found with its legs entwined in dodder *Cassytha racemosa* on 11 February 1987 (Brooker 1987).

Rainbow Bee-eater *Merops ornatus*

The clockwork regularity of arrival and departure by Rainbow Bee-eaters at

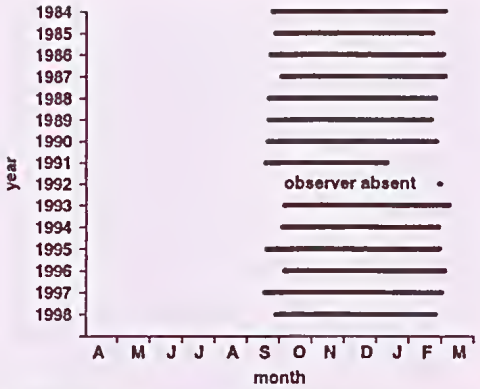

Figure 19. Length of stay of Rainbow Bee-eaters at Gooseberry Hill, 1984-1998.

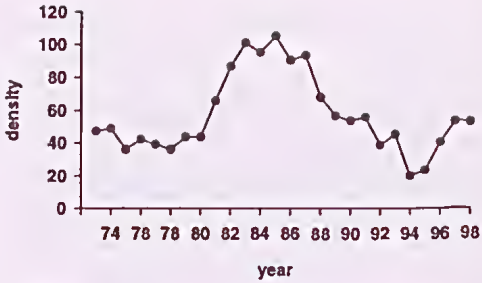

Figure 20. Densities (adults per 100 ha) of Splendid Fairy-wrens on Gooseberry Hill, 1973-1998.

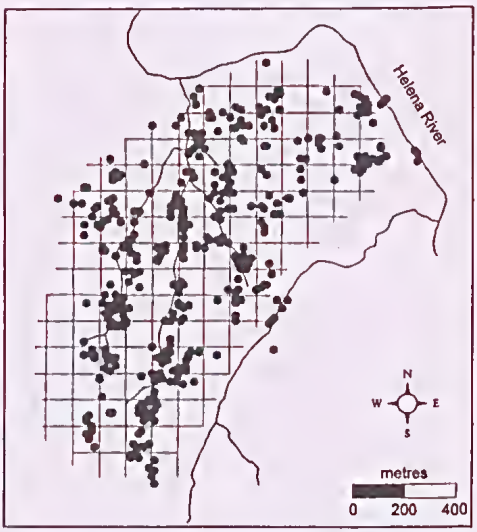

Figure 21. Locations of Splendid Fairy-wren nests (1983-1998) on Gooseberry Hill were mainly in the thicker vegetation along gullies.

Gooseberry Hill is shown in Figure 19. The median date of arrival was 28 September (n = 14), about 2 weeks earlier than for Woorooloo (Sedgwick 1956), whereas the median dates of last sightings were similar - 9 March for Gooseberry Hill (n = 15) versus 12 March at Woorooloo (n = 3). Birds always arrived in late September to early October and the last birds were usually seen in mid March. They nested in the sandy level parts of Gooseberry Hill in the years after fire in the 1980s but not after the 1994 fire. In most years, nests were found at the Lab. Observations at 11 nests suggest that excavations began in mid-October. Fledglings were observed in mid-January (1 record).

Rufous Treecreeper *Climacteris rufa*

One bird was seen feeding on the ground on 12 February 1986.

Splendid Fairy-wren *Malurus splendens*

Splendid Fairy-wrens were found in all habitats on Gooseberry Hill. Over a 26 year period (1973 - 1998), densities fluctuated from 20 to 105 adults per 100 ha (Figure 20), with fire having a major, though indirect, effect (Rowley & Brooker 1987, Brooker & Rowley 1991, Brooker 1998).

The locations of 443 nests are shown in Figure 21. The nesting substrates used were the most varied of all the species examined (Appendix 3); choice of substrate varied depending on time since fire (Brooker & Rowley 1991). The percentage of nests in *Acacia pulchella* was low in 1992 - 1993, when most bushes were dead (6 - 7 years

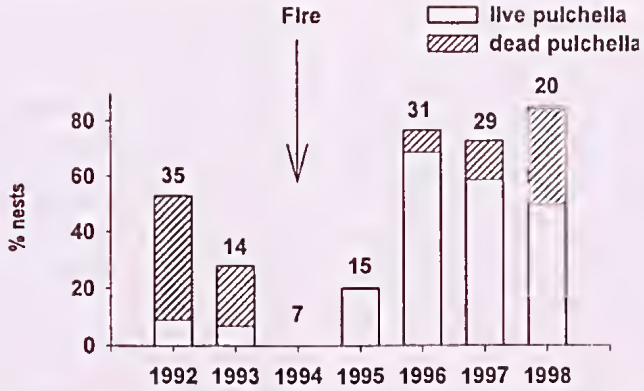

Figure 22. The percentage of Splendid Fairy-wren nests built in live and dead *Acacia pulchella*, 1992-1998 (numbers above show total number of nests found).

unburnt). After the 1994 fire, the wren's choice of *A. pulchella* tracked the life cycle of this obligate seeder, as it regenerated, became abundant and subsequently died (Figure 22).

The breeding biology of the Splendid Fairy-wren is given in detail by Rowley et al (1991). Eggs were laid from late-August to January, mainly September - November. Clutch size was three, mean 2.90; incubation period 14 - 15 d; nestling period 10 - 12 d. From 1973 to 1989, 20% of all Splendid Fairy-wren nests (n = 764) were parasitized by Horsfield's Bronze-Cuckoos, none by Shining Bronze-Cuckoos (Brooker & Brooker 1992).

The results of Ian Rowley's studies of Splendid Fairy-wrens on Gooseberry Hill have made major contributions to the fields of behavioural ecology, cooperative breeding systems, brood parasitism, mating systems and the effects of fire on avifauna (see Bibliography).

Red-winged Fairy-wren *Malurus elegans*

Until January 1987, Red-winged Fairy-wrens were recorded only in the riverine habitat along the Helena River where there is a resident population. However, between 1991 and 1993 they were recorded in some parts of Gooseberry Hill and almost certainly nested there. In the two years after the 1994 fire they were recorded only once, but 3 - 4 groups bred during the following three years, whereas only one group nested in the two years after that, suggesting that in this area they prefer habitat burnt 3-5 years previously. Red-winged Fairy-wrens are commonly found in the wetter gullies on other sections of the Darling Scarp, so it may be that their absence from the gullies on Gooseberry Hill during the early 1980s may have been due to the fire frequency (Brooker 1998).

On two occasions, Red-winged Fairy-wrens nests were found within 50 m of occupied Splendid Fairy-wren nests and, on another occasion, a mixed flock of Splendid and Red-winged fledglings was observed. On 8 October 1998, a male Red-winged Fairy-wren was seen stealing food from a female Splendid Fairy-wren en route to her nest.

Eggs were laid from early September to late November; fledglings seen from early October to late December.

Southern Emu-wren *Stipiturus malachurus*

Emu-wrens were not recorded on Gooseberry Hill, although they have been found about 5 km south on the Darling Scarp, in apparently similar vegetation which is also frequently burnt. One possible explanation for this could be that the escarpment in that area more closely abuts the coastal plain, which might provide a more suitable habitat.

Spotted Pardalote *Pardalotus punctatus*

Spotted Pardalotes were seen occasionally on Gooseberry Hill, mainly in August with few records for December or January and none for February. At Marion Way most records were in June and July. There were few or no records in some years e.g. 1991, 1993, 1995 and 1997 and Serventy recorded Spotted Pardalotes at The Knoll in only 10 of 18 years observation (1957-1974). According to Serventy and Whittell (1976) there may be considerable variation in the numbers reaching Perth from the South-West each autumn.

In this study, they were observed most often in *Eucalyptus rudis* habitat along the Helena River, where they nested in the river bank in 1984 and 1985.

Striated Pardalote *Pardalotus striatus*

Numerous throughout Gooseberry Hill from August to January. In other months, particularly mid-April to July (Figure 23), abundances varied from year to year. Low recording rates in the three years 1985, 1987 and 1994 could have been due to wildfires on Gooseberry Hill the previous summer, although other low years such as 1984 and 1992 could not have been due to fire, nor were the Marion Way figures related to fire. Serventy also noted that they were "absent or almost absent between April and September in some years". Wykes (1985) found that Striated Pardalotes were absent from a Jarrah forest site south-east of Perth during winter 1981, but present throughout 1982. He suggested that changes in density were related to arthropod abundances rather than climatic factors (see also Sedgwick 1971).

Striated Pardalotes nested in live Marri trees and dead and live Wandoos. Building commenced in August; nests with young were recorded from October to December, occasionally as late as January.

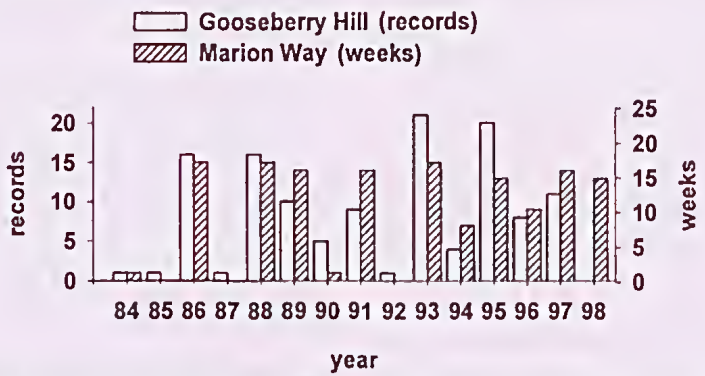

Figure 23. Mid-April to July records of Striated Pardalotes on Gooseberry Hill (solid) and at Marion Way (hatched), 1984-1998.

White-browed Scrubwren *Sericornis frontalis*

A common resident in all heathland habitats that have remained unburnt for at least four years. Uncommon in the years following the major fires of 1985 and 1994, when they were confined to gullies. Movements of two colour-banded males illustrate the scrubwren's intolerance of fire-affected habitat. After the 1987 fire, male #974 left his home territory where he had bred the previous season and moved 1 km to an unburnt area (Figure 24) where he bred successfully for two subsequent seasons. Male 933, who had been a neighbour of #974 in 1986, vacated the burnt area for two years and then returned and bred in his previous territory, now with 3 years post-fire growth.

The average home range of 9 adults during the breeding season was 0.52 ha (Calhome 90% contour, Kie et al. 1994). Dispersal data for 5 individuals

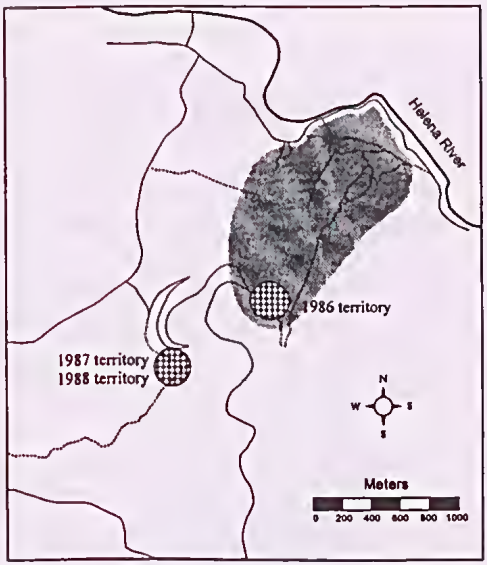

Figure 24. Relative locations of territories (hatched) held by colour-banded male White-browed Scrubwren 974, whose 1986 territory was burnt in February 1987.

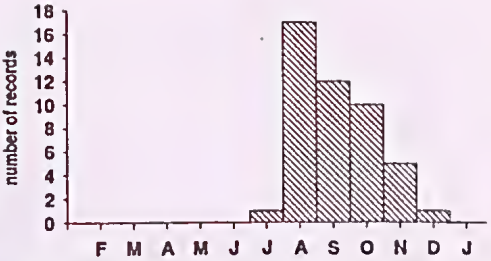

Figure 25. Number of records of White-browed Scrubwrens with fledglings.

banded as nestlings shows that some young were highly dispersive in their first year, with 4 of the 5 moving outside their natal area as early as 2 months post-fledging.

White-browed Scrubwrens nested from July (earliest fledgling 28 July) to November (latest fledgling 1 December) (Figure 25), with most breeding records from August to October. There was no breeding recorded in the 1985 and 1986 seasons following fire and only two records in 1988. One of these nests was built under a pile of dead Marri leaves accumulated from leaf-fall after the fire. Of 41 groups whose chicks or fledglings were seen, six (14.6%) were parasitized by Fan-tailed Cuckoos.

Weebill *Smicrornis brevirostris*

Weebills were permanently sedentary on Gooseberry Hill where they showed a strong preference for areas with Wandoo trees (Figure 26) and a dislike for those with pure Marri. In some sections with good stands of Marri but no Wandoos, Weebills were never recorded in 15 years. However, there were only two records from a relatively dense stand of Wandoos on the south-east side of the area (Figure 26), perhaps because of its isolation from other patches of Wandoo. Weebills were uncommon at Marion Way, where the Marri is the dominant tree (Marri 60 vrs Wandoo 4), being

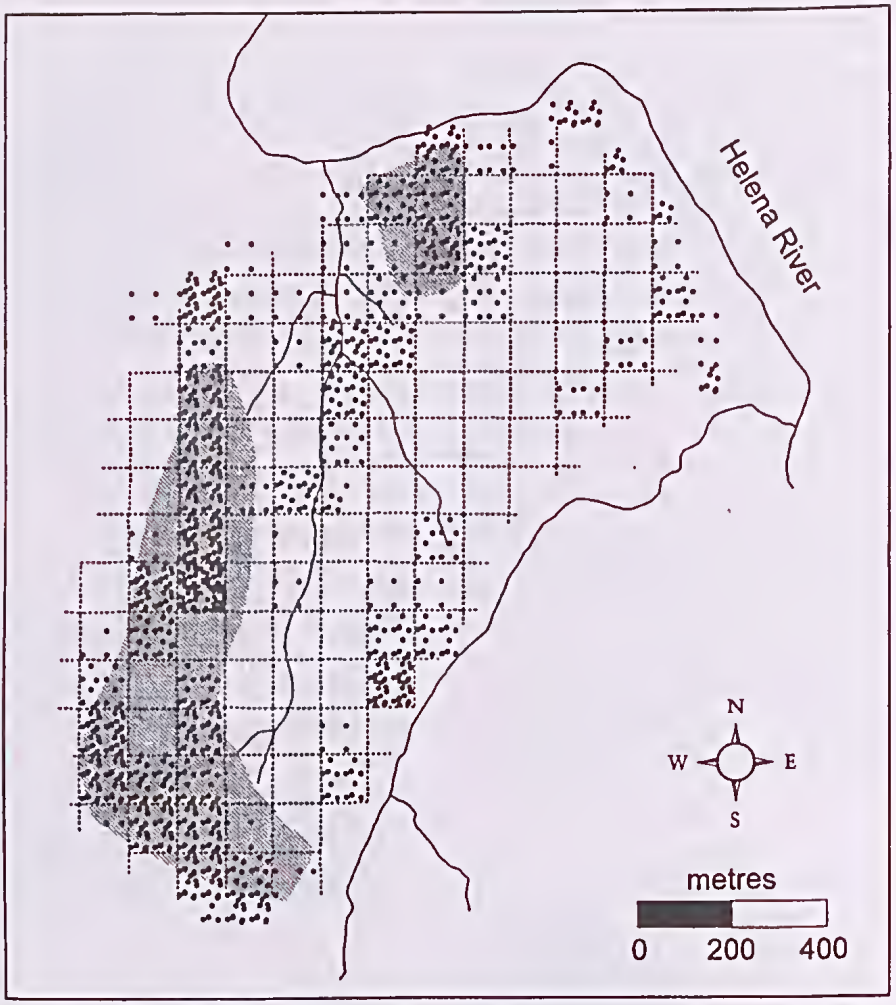

Figure 26. Areas where Weebills were common (shaded), compared to areas were Wandoos were common (stippled) on Gooseberry Hill.

Figure 27. Body mass and wing length of one known-age nestling Weebill.

recorded in only 127 of 780 weeks (16.3%), usually outside their breeding season and not at all in 4 of the years. Weebills were also recorded in Flooded Gums along the Helena River.

Nest building was recorded from 21 July (earliest) to 12 January (latest); earliest eggs 15 August. Both sexes build the nest. All nests found (n = 12) were in Wandoo trees or Marris; height from ground to base of nest 1.5 - 12.0 m. Body mass and wing length of a known-age nestling are shown in Figure 27.

Western Gerygone *Gerygone fusca*

Found in all habitats on Gooseberry Hill in all months of the year. Although there were few records in the three months following a major fire (3 records after the January 1985 fire, none after the 1994 fire), some breeding activity was observed in the spring of these years.

Few nests were found, but the number of fledglings gives a good indication of breeding as fledglings of this species are readily detected by call. Although nest building was observed as early as late-August, most fledglings were recorded from November to January (Figure 28). At one nest where both adults were colour-banded, only the female did the building.

In Jarrah forest south-east of Perth, Wykes (1985) found a summer peak in the abundance of active, foliage-dwelling insects. He suggested that this was related to a preference for summer breeding by Weebills.

Observations of five adults colour-banded at Marion Way (Table 4) indicate that Western Gerygones are resident breeders there.

Inland Thornbill *Acanthiza apicalis*

Recorded along the Helena River and on the southern edge of the Gooseberry Hill area, less frequently elsewhere. The numbers of Inland Thornbills were lowest in the three years following the January 1985 fire and more especially in the five years following the 1994 fire when only three records were made.

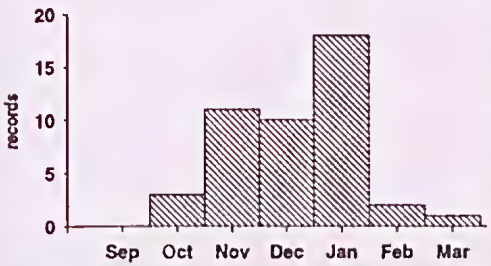

Figure 28. Number of records of fledgling Western Gerygones.

Table 4. Observation histories of five colour-banded Western Gerygones at Marion Way.

band	date	observation
XRY	28 July 1984	banded
	6 April 1985	present
	2 November 1985	with fledgling & YBX
YBX	25 November 1984	banded
	2 November 1985	with fledgling & XRY
	10 April 1986	present
	27 January 1987	with fledgling
XGY	21 November 1987	banded
	31 December 1987	at nest
	10 March 1988	present
	3 April 1988	present
	30 January 1989	present
	4 February 1989	with fledgling
RX	28 December 1993	banded
	9 January 1995	with fledgling
	30 August 1996	present
	1 January 1997	with fledgling
	28 June 1997	present
BX	22 July 1998	banded
	10 February 1999	with fledgling

Nests were found only in vegetation that had remained unburnt for at least 4 years. Eggs were laid from 14 August (earliest) to 13 October (latest) (n = 11). Ten nests were built in shrubs (mean height 1.0 m, range 0.7 - 1.4 m) and one in a Marri tree at 4.5 m (Appendix 3). Three nests fledged a Fan-tailed Cuckoo and two contained an egg of the Shining Bronze-Cuckoo, one of which fledged.

One male, banded in August 1984, was seen again on Gooseberry Hill until

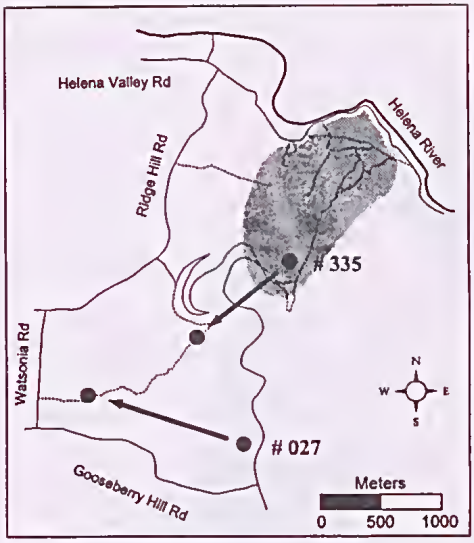

Figure 29. Movements by two Inland Thornbills.

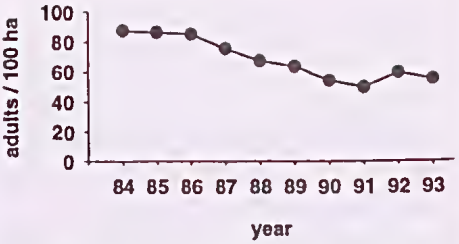

Figure 30. Adult densities of Western Thornbills on Gooseberry Hill, 1984-1993.

April 1985, two months after the 1985 fire. He then disappeared from the area and was found nesting in unburnt habitat 1 km away the following spring (#335, Figure 29). Another bird (#027), netted at Marion Way in December 1993 was seen there again in July 1995, then once again three days later in heathland 1.2 km away.

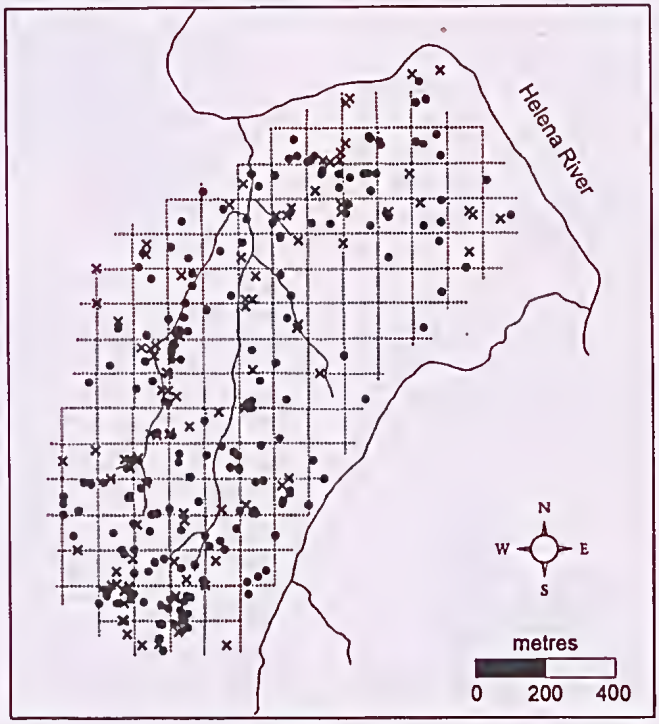

Figure 31. Locations of 315 nests of Western Thornbills 1983-1998; in Balgas *Xanthorrhoea preissii* (dots) and other plants (crosses).

Western Thornbill *Acanthiza inornata*

Western Thornbills were common resident breeders on Gooseberry Hill. They were less common in riverine habitats and rare at the Lab and Marion Way. Densities on Gooseberry Hill from 1984 to 1993 (Figure 30) showed a decline in the eight years following the major fire in 1985, falling from 86.4 birds per 100 ha in 1985 to 49.7 in 1991. A detailed account of the effects of fire on Western Thornbills is given by Brooker & Rowley (1991) and Brooker (1998).

Western Thornbills bred throughout Gooseberry Hill (Figure 31) in all habitats. Sixty-three percent of nests were in Balgas *Xanthorrhoea preissii* (Appendix 3); with a further 25% in knotholes, spouts, crevices and under the bark of Marris, Wandoos and other trees.

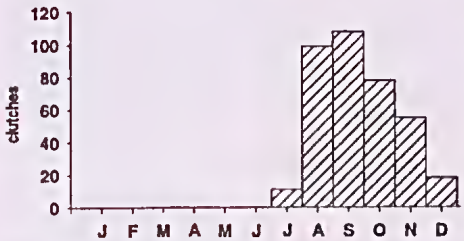

Figure 32. Lay dates of 355 clutches of Western Thornbill eggs.

Eggs were laid from mid-July to mid-December; median second week of September (n = 355) (Figure 32). Clutch size was usually three; incubation period 18 – 19 d; nestling period 17 – 19 d.

From 1984 to 1991, 13% of nests (n = 325) were parasitized by cuckoos; 8% by Horsfield's Bronze-Cuckoos and 5% by Shining Bronze-Cuckoos (Brooker & Brooker 1992). Growth curves for nestling Western Thornbills are shown in Figure 33.

Yellow-rumped Thornbill *Acanthiza chrysorrhoa*

The Yellow-rumped Thornbill is a resident breeder on Gooseberry Hill, found in most habitats across the area, but most frequently in open country. Estimated densities from 1985 to 1998 are shown in Figure 34. An estimate of density for 1984, based on sightings and the number of nests found, suggests that there were no more than six groups at that time, so that the increase in numbers from 1985 to 1987 must have been due to immigration into the area. The more open habitat created by the 1985 and 1987 fires may have promoted this. However, no similar increase followed the 1994 fire.

In 1987 and 1988 there were seven groups nesting in the grounds of the

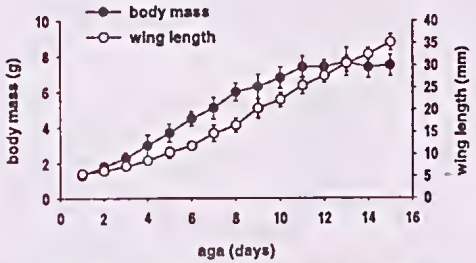

Figure 33. Body mass and wing length for known-age nestling Western Thornbills (n = 11-31).

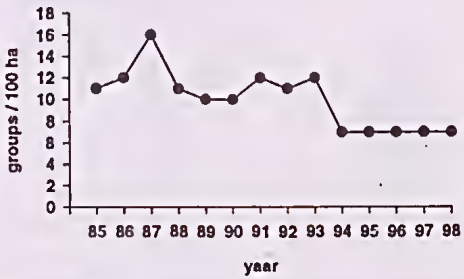

Figure 34. Densities of Yellow-rumped Thornbills on Gooseberry Hill 1985-1998.

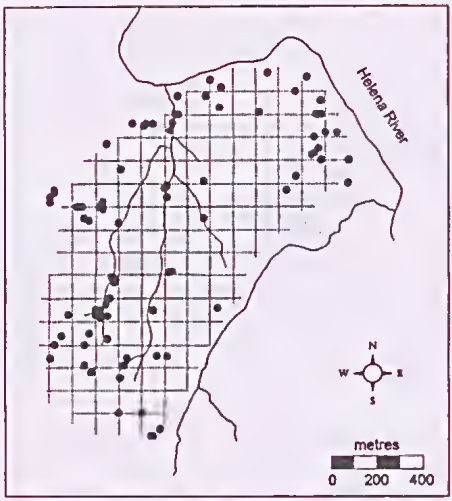

Figure 35. Locations of 137 Yellow-rumped Thornbill nests on Gooseberry Hill, 1984-1998.

Lab. From that time onward, numbers at the Lab appeared to decrease in line with the densities on Gooseberry Hill. Yellow-rumped Thornbills nested regularly in the Picnic Area and in Farrant's Paddocks (up to the time of redevelopment) but were rarely sighted at Marion Way.

Yellow-rumped Thornbills nested throughout Gooseberry Hill (Figure 35), preferring the more open habitats. Most nests were in trees (Appendix 3), although Balgas *Xanthorrhoea preissii* were also used, especially at the Picnic Area. Unlike Western Thornbills that hide their nests in *Xanthorrhoea* fronds, Yellow-rumped Thornbills attach their nests below the skirt, often precariously. *Hakea lissocarpha* was used only if it had remained unburnt for many years (Brooker & Rowley 1991) (Figure 36).

Eggs were laid from the last week of July to the first week of December, median week 3 of September (n = 136). Clutch size was usually three; incubation period 16 - 19 days; nestling period 18 - 21 days. From 1984 to 1991, 32% of nests (n = 81) were parasitized by Shining Bronze-Cuckoos (Brooker & Brooker 1992). Growth curves for nestling Yellow-rumped Thornbills are given in Figure 37.

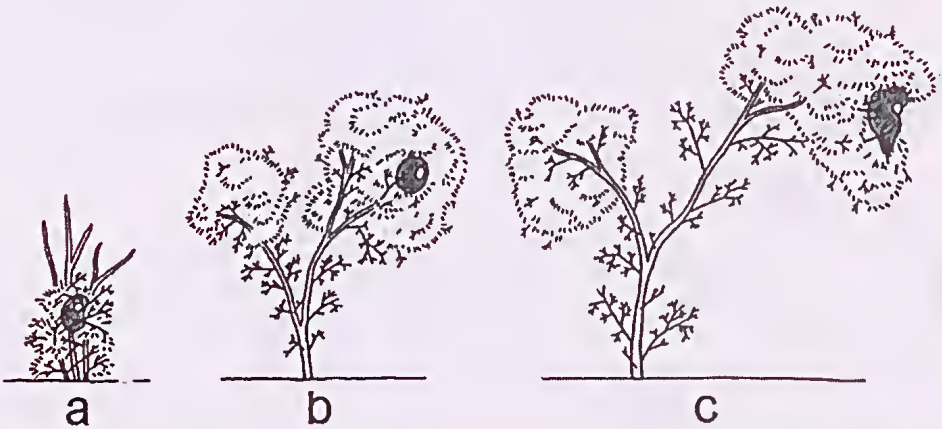

Figure 36. *Hakea lissocarpha* is used by (a) Splendid Fairy-wrens 1-2 years after fire; (b) Western Thornbills 6 or more years after fire; (c) Yellow-rumped Thornbills only if long unburnt.

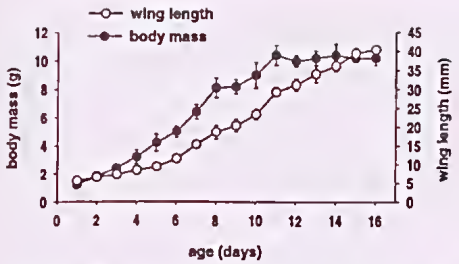

Figure 37. Body mass and wing length of known-age Yellow-rumped Thornbills (n = 2 - 18).

Red Wattlebird *Anthochaera carunculata*

Occupies mainly the northern and southern parts of Gooseberry Hill, where it abuts farmland and suburbia (75% of records). Those birds seen on the central area were usually in transit or foraging on flowering Marri in late summer. Fledglings (n = 33) were observed at the Lab and at Marion Way from July (1 record) to March (3 records) with most from November to January (14). Earliest egg 31 July; latest fledgling 16 March. Three birds for which fledging date was recorded still gave begging calls after 42, 58 and 59 days.

Western Wattlebird *Anthochaera chrysoptera*

Seen in adjoining suburbia, but only rarely on Gooseberry Hill itself, where there were only seven records in 15 years.

Singing Honeyeater *Lichenostomus virescens*

Recorded throughout the year along the Helena River and those parts of Gooseberry Hill adjoining it, but only seven records in 15 years from elsewhere. Singing Honeyeaters may have increased in suburbia here, as Serventy gave no record for The Knoll, 1957-1974. Although at Marion Way there were few records for 1984 – 1990 (recorded on average 3 weeks per year) in the following 8 years they were recorded on 33 weeks per year. They were rarely seen mid-September to mid-November at Marion Way, suggesting that they moved elsewhere to breed.

A nest containing young was found at the Lab on 5 October 1988 and a fledgling was seen on Gooseberry Hill on 13 December 1992.

Yellow-plumed Honeyeater *Lichenostomus ornatus*

Rarely seen on Gooseberry Hill. Observed in June 1985 and June 1990 on flowering Wandoo, and twice during August 1990. Only once seen at Marion Way, in June 1987, on flowering *Dryandra sessilis*. Serventy recorded this species between April and August in 1958, 1959, 1960, 1961 and 1972 at The Knoll, and Mawson and Massam (1995) give one record (March 1992) during three years observations at Forrestfield.

Brown-headed Honeyeater *Melithreptus brevirostris*

Twenty-five records were made on Gooseberry Hill over 15 years, 17 of them during spring (Sept - Nov). One pair (including one banded bird) nested in the same Wandoo tree in the September of 1985 and 1986.

White-naped Honeyeater *Melithreptus lunatus*

Very rare on Gooseberry Hill, with just three records made in 15 years, in May and June. Seen occasionally at the Lab and along Helena River from March to September. No records from October to February. Observations at Marion Way were similar; rare with a peak in numbers in June and July; no records from October to February.

Brown Honeyeater *Lichmera indistincta*

Brown Honeyeaters are present on Gooseberry Hill throughout the year, in all habitats. They tend to be less numerous in summer and early autumn, especially during January and February. In late autumn, their numbers appear to increase until mid July to early August, when they might be described as "noisy and numerous throughout". Exceptional winters were those of 1985, 1987 and 1994, following major fires. In these years, of the few nests found, none were successful.

Figure 38. Body mass and wing length of known-age nestling Brown Honeyeaters (n = 2-7).

In other years, nesting occurred from August (earliest building) to December (latest nestlings). Of 13 nests with

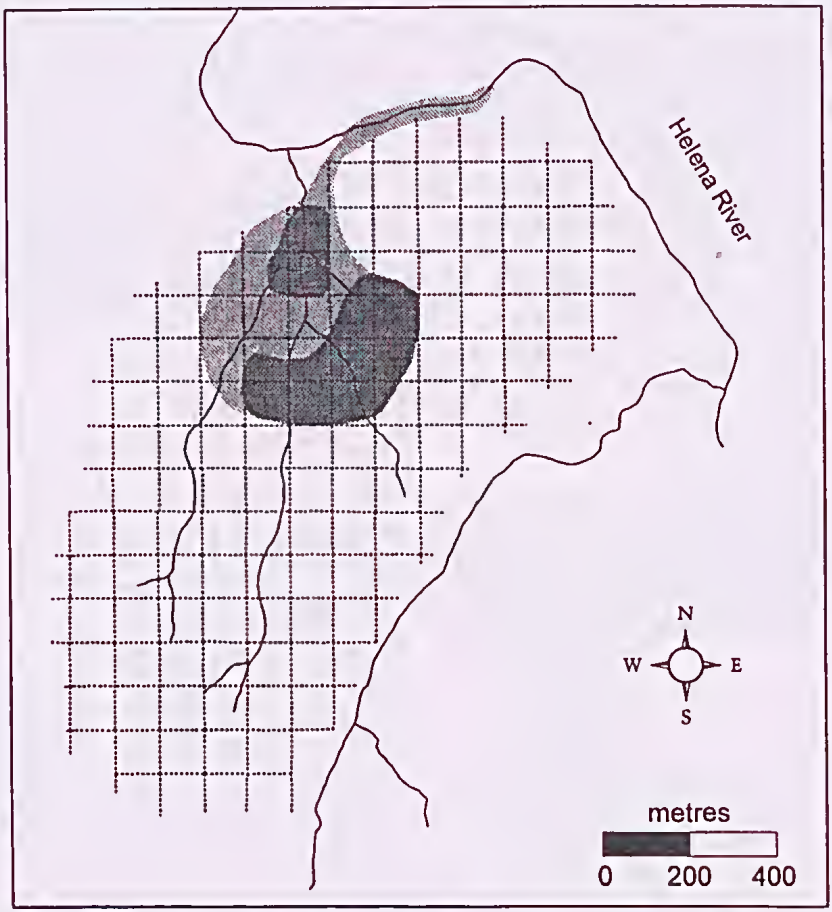

Figure 39. Locations where New Holland Honeyeaters were commonly recorded (darker shading) and infrequently recorded (lighter shading).

detailed observations, 12 contained two eggs or nestlings, and one had three nestlings. At least 22 different trees or shrubs were used as nesting substrates (Appendix 3). Nest height varied: 3 - 5 m in Marris (n = 2); 0.9 - 1.6 m in Balgas *Xanthorrhoea preissii* (n = 4); 0.3 - 1.1 m in shrubs (n = 26); overall median 0.7 m; overall mean 0.76 m ± 0.24. One nest, that fledged two Brown Honeyeaters on 19 November 1985, was built inside an old Splendid Fairy-wren nest that had been relined with *Macrozamia riedlei* bast. Incubation period 13 - 14 d (n = 2); nestling period 15 d (n = 2). Growths curves for body mass and folded wing length of nestlings are shown in Figure 38.

A total of 161 adults, 10 juveniles and 39 nestlings were banded. Eight were retrapped at or near their banding site: three males 1, 2 and 69 months after banding; two females after 13 and 17 months; one nestling after 11 months and two unsexed adults after 10 and 12 months.

New Holland Honeyeater *Phylidonyris novaehollandiae*

While numerous at the Lab and along the river, New Holland Honeyeaters were not common on Gooseberry Hill. The majority of records were made from August to October, mainly during the period 1991-1993, when the vegetation had 7 - 9 years of regrowth following the 1985 and 1987 fires. Most records were from the northern edge of Gooseberry Hill, near the river and the lower reaches of the main gully (Figure 39), where breeding was recorded in 1990-1993.

New Holland Honeyeaters were often observed feeding on flowering *Dryandra sessilis*, which regenerates from seed after fire, and less frequently on invertebrates taken from the trunks of

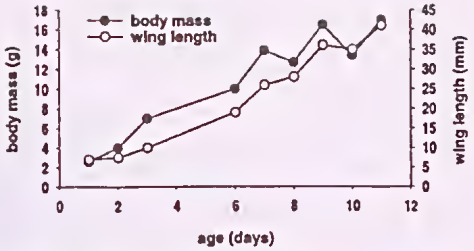

Figure 40. Body mass and wing length of one nestling New Holland Honeyeater.

Marri, sometimes in company with Western Spinebills and Brown Honeyeaters.

Fledglings were seen from July to November. In two nests, incubation period was 14 - 15 d. Eggs were laid at 24 h intervals. Growth curves for one nestling are shown in Figure 40.

White-cheeked Honeyeater *Phylidonyris nigra*

Recorded on Gooseberry Hill in dense vegetation in gullies, but not along the Helena River (Figure 41). Seen mainly from April to December (Figure 42), except in the years following major fire (no records 1985, 1986, 5 in 1987, none in 1994, 1995 or 1996). At Marion Way, most frequently recorded in January and February when mistletoe *Amyema preissii* was flowering and in May and June on *Dryandra sessilis* (Figure 42).

Nests were found in a variety of shrubs (Appendix 3) and Balgas *Xanthorrhoea preisii* from 0.4 to 1.8 m above ground (n = 6). Clutch size was 2 in all nests found with eggs (2) and young nestlings (4). Of 14 breeding records, the earliest hatch was 27 June, the latest 11 November; fledglings were seen from August to November. Growth curves for 2 nestlings are given in Figure 43.

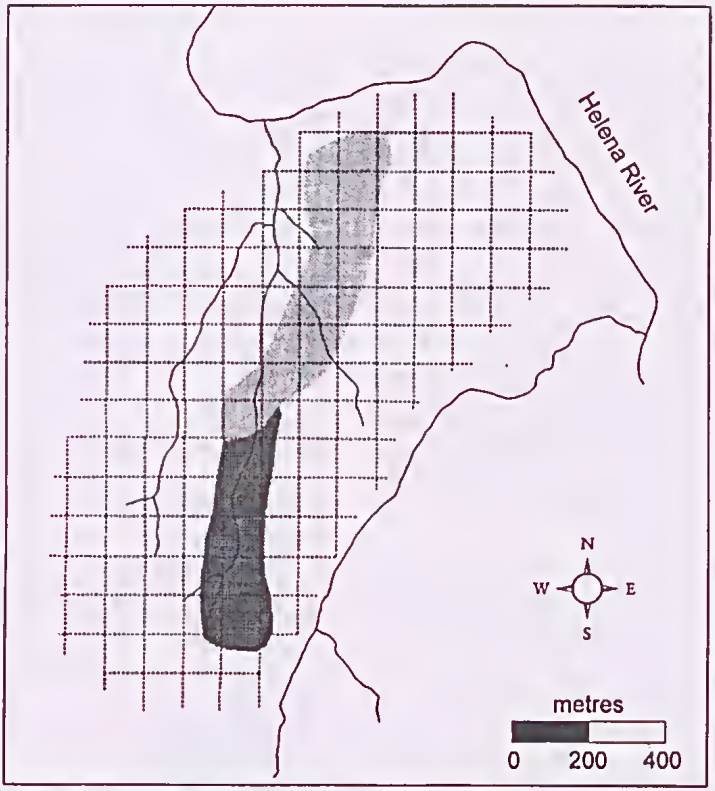

Figure 41. Locations where White-cheeked Honeyeaters were commonly recorded (darker shading) and infrequently recorded (lighter shading) on Gooseberry Hill.

Figure 42. Records of White-cheeked Honeyeaters at Marion Way and Gooseberry Hill, 1984-1998.

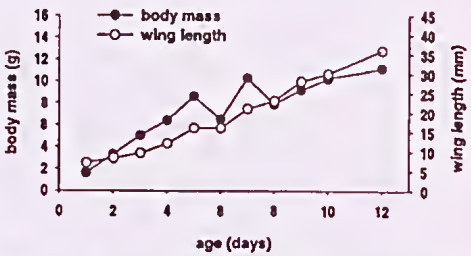

Figure 43. Body mass and wing length for 2 known-age nestling White-cheeked Honeyeaters.

Tawny-crowned Honeyeater *Phylidonyris melanops*

Tawny-crowned Honeyeaters were the second most abundant honeyeater on Gooseberry Hill, after the Brown Honeyeater. Some were present

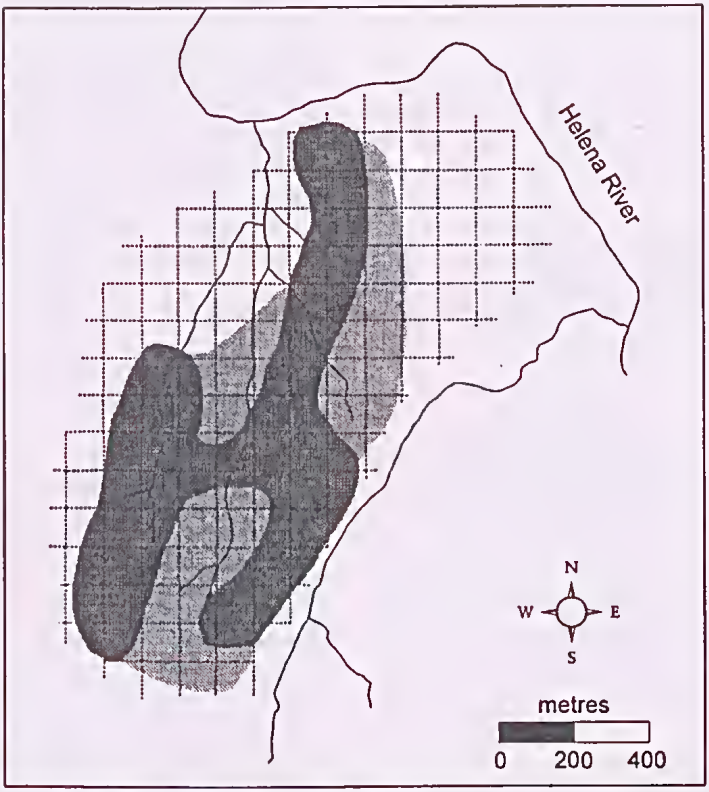

Figure 44. Locations where Tawny-crowned Honeyeaters were commonly (dark shading) and infrequently (light shading) recorded.

throughout the year , usually on the slopes and ridge tops rather than the gullies (Figure 44). They were never recorded in the riverine habitat, at the Lab or at Marion Way and there few records in the six months following the hot summer fires of 1985 and 1994, although they nested in resprouting shrubs the following spring. Numbers were lowest from late summer to early autumn when they appeared confined to areas of flowering *Calothamnus hirsutus*.

Over 60 breeding attempts were recorded over an extended season from July to January (Figure 45). Earliest eggs 28 July; latest eggs 15 December. Of nests found with eggs: C1 (1), C2 (16), C3 (1); of nests found with young: one chick (4), two chicks (11), three chicks (2). Of 31 nests where the nesting substrate was recorded, 16 were in *Dryandra armata* (Appendix 3). The median height from ground to base of nest was 0.28 m, range 0.10 to 1.0 m (n = 28). Growth curves for two nestlings are shown in Figure 46.

A total of 24 adults and 15 nestlings were colour-banded. The small number of subsequent sightings suggests that the population at Gooseberry Hill is mobile. Only two males and two females originally trapped at nests, were ever seen again; the males 13 and 24 months after banding; the females both 11 months later. One young bird banded as a nestling, was seen again near the natal

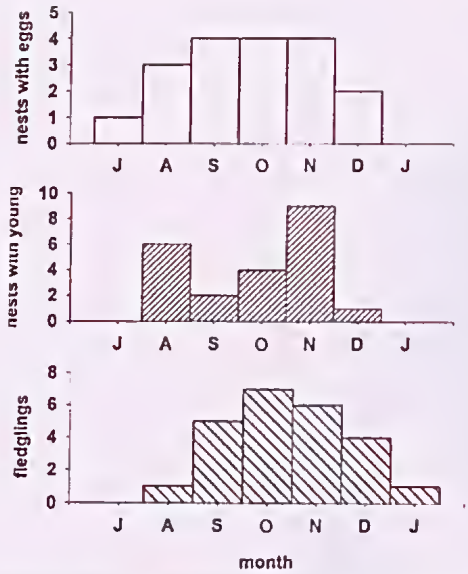

Figure 45. Breeding season of Tawny-crowned Honeyeaters at Gooseberry Hill, 1984-1998.

Figure 46. Body mass and wing length of two known-age nestling Tawny-crowned Honeyeaters.

area after 17 months. None of eight birds netted on flowering *Calothamnus sanguineus* in April were ever resighted.

Western Spinebill *Acanthorhynchus superciliosus*

The occurrence and abundance of Western Spinebills on Gooseberry Hill were erratic, both within and between years. While there were records for all months of the year (Figure 47) with a May - August peak, the species was rare or absent in the May - August period of 1994, 1997 and 1998. Moreover, they were common during summer in 6 of the 15 years, and rare or absent in the rest. Very low numbers seen in 1985 and 1994 suggest that this species may be adversely affected by fire, although there was no immediate recovery in 1995 as there was in 1986 (Figure 47). The distribution of Western Spinebills across Gooseberry Hill tended to favour areas of Wandoo.

The few nests found were in the foliage of Eucalypts or *Nuytsia floribunda* at a height of 5 to 12 m.

Fledglings were recorded from August to January. One male was observed building a nest in a *Nuytsia floribunda* on 20 August 1986. During a hide-watch at an Inland Thornbill nest on 17 August 1988, a female spinebill twice raided the nest, removing lining material which she carried to her own nest, and tossing an egg out of the thornbill's nest in the process. The thornbill's nest was subsequently deserted.

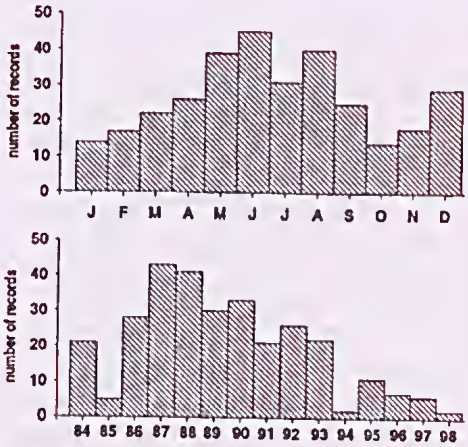

Figure 47. Number of records of Western Spinebills on Gooseberry Hill, according to month (top) and year (bottom).

Table 5. Observation histories of three male and three female colour-banded Western Spinebills at Marion Way (Landor Rd is 200 m south of Marion Way).

band	date	observation
OYO	8 March 1987	banded
(fem)	March 1987	seen
	April 1987	seen
	May 1987	seen
	September 1987	seen
	11 October 1987	seen with fledgling
YBR	3 February 1991	banded
(fem)	10 January 1993	retrapped
RBR	12 February 1995	banded
(fem)	1 February 1998	retrapped
	11-25 April 1998	seen
NGO	27 August 1994	banded
(male)	29 October 1994	seen with fledgling
	23 April 1999	seen Landor Rd
RYO	22 December 1995	banded
(male)	18 February 1996	seen Landor Rd
NOO	30 May 1993	banded
(male)	18 February 1996	seen Landor Rd
	26 May 1996	seen Landor Rd
	7 July 1996	seen Landor Rd
	5 October 1996	seen Landor Rd
	17 May 1997	seen Landor Rd
	17 January 1998	seen Landor Rd
	21 February 1998	seen Landor Rd
	7 March 1998	seen Landor Rd

Western Spinebills were seen foraging on flowering *Calothamnus hirsutus* in February and March; *C. sanguinius* in April and May; and *Grevillea bipinnata* in most months of the year. There were a number of records of Western Spinebills taking invertebrates from the trunks of Marri trees.

A total of 60 individuals were colour-banded. The longest time to resighting for a male was 57 months after banding, and for a female, 50 months later. One banded pair nested on Gooseberry Hill in the breeding season following the 1985 fire. The male was again recorded in the same area in 1986 and 1987. Details of three males and three females banded at Marion Way are given in Table 5. Their pattern of resighting suggests an erratic presence; i.e. not seen at all in some years, nesting in other years. Of course, one explanation for this may be that their home range shifts from one year to the next.

Scarlet Robin *Petroica multicolor*

Scarlet Robins are resident breeders on Gooseberry Hill. Densities ranged from 4 to 7 pairs per 100 ha over 15 years. Numbers were highest in the period 1985 - 1989, following the 1985 fire, which suggests that they favour recently burnt habitat; although there was no increase in numbers after the 1994 fire (Brooker 1998).

Scarlet Robins nested in Marri trees (n = 10; nest height 2 - 12 m), Balgas

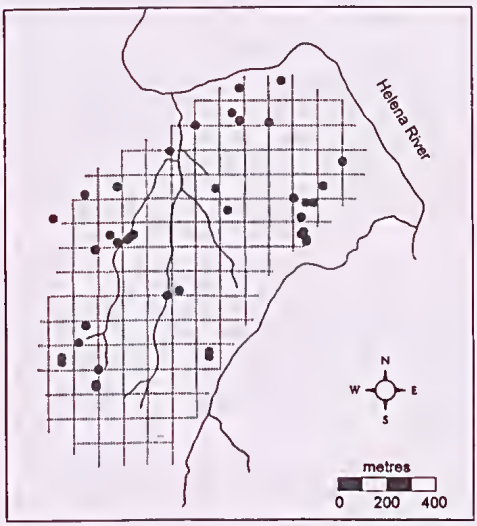

Figure 48. Locations of Scarlet Robin nests on Gooseberry Hill, 1984-1998.

Xanthorrhoea preissii (n = 9; 1.0 - 1.7 m) and *Nuytsia floribunda* (n = 1; 3.9 m). Nests in the forks of multi-headed Balgas were particularly well hidden by the skirt, even when the plant had been burnt the previous summer. The distribution of nesting sites is shown in Figure 48. Of 36 nesting attempts in which the outcome was known, four were parasitized by Horsfield's Bronze-Cuckoos, three in 1985 and one in 1987. Of 16 nests found with eggs or nestlings, eight fledged young robins or cuckoos.

Red-capped Robin *Petroica goodenovii*

The numbers of Red-capped Robins on Gooseberry Hill fluctuate considerably. They were numerous in the 12 months following each of the major fires in 1985 and 1994; seen occasionally in other years in the cleared country of the Lab grounds and Farrant's paddocks; and absent altogether in 1991, 1992 and 1998. Their appearance after fire has been reported from other areas near Perth, e.g. Pipidinny (WA Bird Notes 73: 8) and Ellis Brook (WA Bird Notes 74: 8).

Birds, mainly juveniles, were recorded most frequently in autumn (March to May). Similar observations were made by Green (1998) who observed a pair at Kelmscott in May; and Bremner (1996), who regularly observed a pair that visited Kalamunda National Park between late March and early May.

Some birds move toward the west coast in late summer and early autumn and return east in late autumn or winter (Storr 1991). However, if conditions are suitable, (e.g. after fire) some may remain all year.

Nesting was recorded from 1985 to 1988 and in 1990. One banded male was resident in the orchard at the Lab for two years from August 1987. He was accompanied by an unbanded female

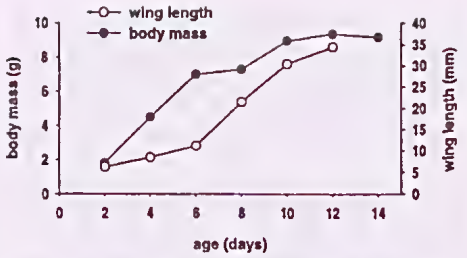

Figure 49. Body mass and wing length for two known-age nestling Red-capped Robins.

and the pair presumably nested there. A pair of Scarlet Robins had a territory that overlapped that of the Red-capped Robins in both years. Growth curves for two nestlings are shown in Figure 49.

Hooded Robin *Melanodryas cucullata*

A female or juvenile Hooded Robin was seen on four occasions in 1987 between 24 September and 2 October.

White-breasted Robin *Eopsaltria georgiana*

First seen in the riverine habitat in May 1996. A single White-breasted Robin was seen in the same area in April 1998 and one was netted there in May 1998. Calls were heard in that area and elsewhere along the Helena River in September and October 1998, particularly those parts with Karri Hazel *Trymalium floribundum*, which is a favoured component of White-breasted Robin habitat in the South-West (Serventy & Whittell, 1976). Napier (1998) recorded White-breasted Robins on the river upstream of the picnic area (Figure 1) in June 1998. They nested in the riverine vegetation in 1999, where a pair were observed feeding a Pallid Cuckoo fledgling in November.

Varied Sittella *Daphoenositta chrysoptera*

At least two groups of Varied Sittellas

have been observed from time to time on Gooseberry Hill (170 records in 15 years). They were recorded most often from May to December (92% of records) and more frequently seen in areas with Wandoo or Flooded Gum than those with Marri trees. Weekly records for Marion Way show regular visits from February to August but very few in other months, presumably because they do not nest in suburbia.

Group size varied from 2 to 15; median group size for March - August, 5.5; other months 3.5. Fledglings were observed in November and December.

One group was seen "hawking" winged bullants at 1600 h on 21 July 1992. The birds flew out about 0.5 m from a 10 m perch to capture the ants.

Golden Whistler *Pachycephala pectoralis*

An uncommon winter visitor, Golden Whistlers were recorded on 54 occasions, 76% of these in June, July and August. Of 39 sightings of individuals, only two were in male plumage.

Rufous Whistler *Pachycephala rufiventris*

A common resident, present on all areas throughout the year. At Marion Way, recorded in all weeks. The Rufous Whistler appears to be a late nester in this area. Fledglings were seen only from November to February.

Four colour-banded males were resighted in the same area 19, 28, 38 and 38 months after banding and two females 19 and 36 months after banding.

Grey Shrike-thrush *Colluricincla harmonica*

Not common on Gooseberry Hill, with only 242 records made in 15 years; 95% of sightings were between May and

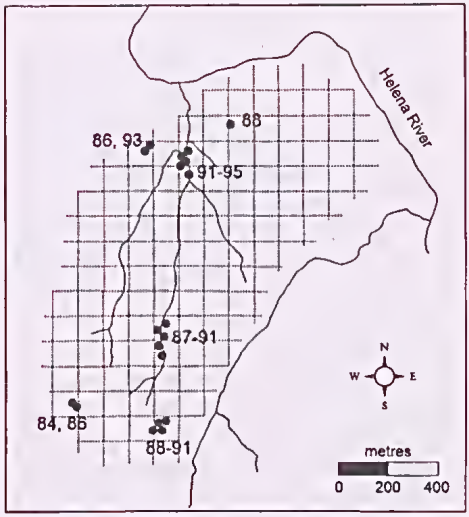

Figure 50. Spatial and temporal distribution of Grey Shrike-Thrush sightings on Gooseberry Hill.

December. The Grey Shrike-thrush was absent in areas burnt by the major fire in 1985 but present in the 1994 post-fire period. The spatial and temporal distribution of sightings (Figure 50) was clumped, suggesting that only one or two pairs made opportunistic use of the area in some years.

One adult female colour-banded at a nest on 13 December 1988 was resighted 400 m away on 27 June 1990 and again on 5 December 1990, 600 m from the nest area.

Four breeding records were made - a female carrying food on 8 October 1984; a nest with 3 eggs on 7 December 1988; a nest with 2 nestlings on 30 October 1993; one fledgling on 13 December 1991.

Restless Flycatcher *Myiagra inquieta*

A single bird was seen on 6 May 1991 on the south-western edge of Gooseberry Hill and at Marion Way.

Magpie-lark *Grallina cyanoleuca*

Recorded in riverine habitat and the cleared country adjoining it. Rare in the heathland, even after fire. Twenty-three records were made over 15 years, with only eight of these in areas away from the Helena River. Nest building was observed between 30 August and 19 October at the Lab. The earliest fledglings were seen on 23 September; the latest on 8 January.

Grey Fantail *Rhipidura fuliginosa*

Common on Gooseberry Hill, where the number of sightings peaked in March every year. Fewer birds were recorded after August, with only one observation made in October from areas other than the vegetation along the Helena River, the only habitat where breeding was recorded.

Birds were found building on 12 September and 30 September; nestlings recorded from 26 September to 3 December (n = 6); fledglings recorded from 3 November to 31 December (n = 6).

Three of six adults colour-banded were resighted at the banding site. One individual banded on 17 June 1987 was seen 11 months later, one banded on 26 January 1990 was seen again on four occasions up to 4 months after banding, and another banded on 9 March 1990 on two occasions up to 8 months later.

Willie Wagtail *Rhipidura leucophrys*

Seen occasionally on Gooseberry Hill (43 records), usually in areas adjoining either the river or the cleared country. There appeared to be no seasonal variation in occurrence and no detectible changes after fire. Willie Wagtails were present in the grounds of the Lab throughout the period of study and nested there. The earliest breeding record was 28 August (building); latest 16 November (nestlings fledged).

Of six Willie Wagtails colour-banded at the Lab, three were resighted: one for 3 months at the Lab; one for 51 months at the Lab; and a third individual for 14 months at the Lab and thereafter for another 12 months, 1 km away in a semi-urban area on the opposite side of the river. A sheep that strayed onto Gooseberry Hill in April 1987 was accompanied by a Willie Wagtail.

Black-faced Cuckoo-shrike *Coracina novaehollandiae*

Present on Gooseberry Hill throughout the year. Flocks, consisting mainly of adults, were recorded in May and June. Juveniles were recorded from October onwards, mainly between November and January. Nests with young were found on 7 November 1986, 19 November 1987 and 11 December 1992.

White-winged Triller *Lalage sueurii*

A common breeding species on Gooseberry Hill in some years; rare or absent in others; only one record in 1996, none in 1998. The earliest date of arrival was 26 July 1987, the latest departure date 3 March 1987 (Figure 51). White-winged Trillers were most abundant in the years after the 1985

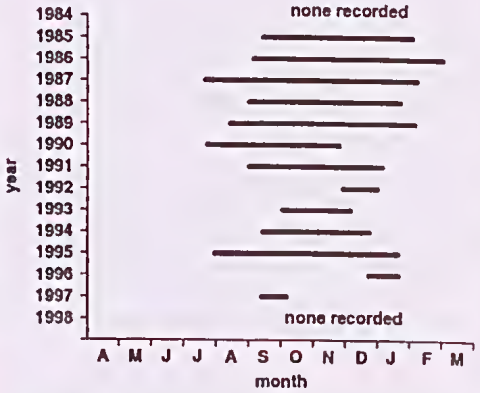

Figure 51. Length of stay of White-winged Trillers at Gooseberry Hill, 1984-1998.

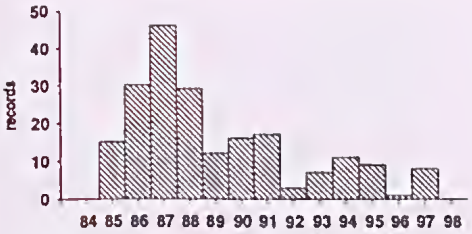

Figure 52. Number of records of White-winged Trillers on Gooseberry Hill, 1984-1998.

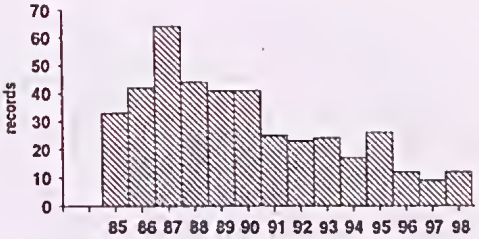

Figure 53. Numbers of Dusky Woodswallow records on Gooseberry Hill, 1984-1998.

fire, although there was no similar influx and no nest records after the 1994 fire (Figure 52).

Breeding was recorded from September to December; most fledglings were seen in December.

Masked Woodswallow *Artamus personatus*

Flocks of Masked Woodswallow were seen on Gooseberry Hill on four occasions: 18 and 28 September 1985, 22 October 1990 and 10 October 1994. Similar sightings were not recorded in WA Bird Notes for other parts of the Perth area.

Dusky Woodswallow *Artamus cyanopterus*

Dusky Woodswallows were rare on Gooseberry Hill in the two years prior to the January 1985 fire (I. Rowley per. comm.). In the following eight years, they increased in numbers, with a peak density in the breeding season following the 1987 fire (Figure 53). During this period (1985-1992) they were present throughout the year. Of the five nests found in later years (1990 and 1991), four were in or near a small area burnt in January 1990. These records suggest a positive response to fire by this species, although few birds were seen in the five years after the February 1994 fire and those that were seen did not stay throughout the year.

The locations of nests (Figure 54) were clumped, although there were no obvious vegetation or landscape attributes which might explain this. Nests were built in trees and Balgas *Xanthorrhoea preissii* (Appendix 3): median height 4.0 m (n = 20); range 1.2 - 10 m. For 20 nests with detailed observations, clutch size was 3 (n = 6) or 4 (n = 2); 11 (55%) fledged young; at 16 nests there were 2 adults present; at four nests, at least 3 adults. Two groups in 1985 renested with at least one of the previous brood surviving. In one case the renesting interval was 51 d (hatch to hatch), in the other 65 d

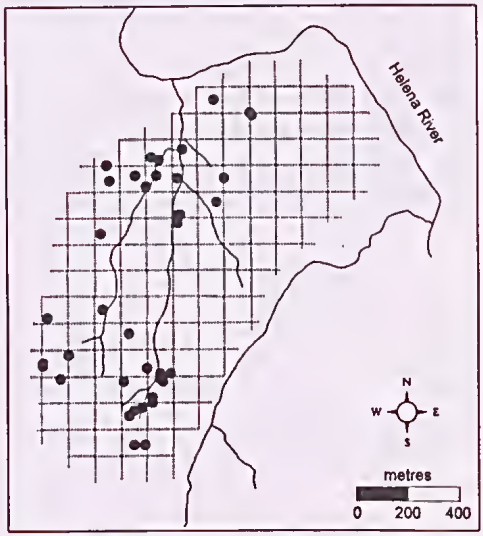

Figure 54. Locations of Dusky Woodswallow nests on Gooseberry Hill, 1984-1998.

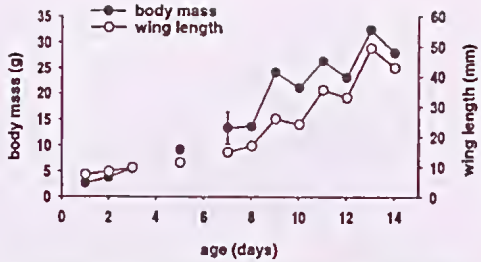

Figure 55. Body mass and wing length for known-age nestling Dusky Woodswallows (n = 1-5).

(fledge to fledge). Growth curves for nestlings are shown in Figure 55.

A total of 21 adults were colour-banded. Most were resighted on Gooseberry Hill and most nested there. Over a seven year period, one male was present at nests in 1986, 1987, 1989, 1990 and 1992. He was observed copulating on one occasion.

Of the 29 colour-banded nestlings, 10 were seen again on Gooseberry Hill on one or more occasions and one was found dead 1.1 km from its nest site, 9 months after banding. Another juvenile was caught in a chicken coop 1.5 km south-west of its nest site 6 weeks after banding.

Grey Butcherbird *Cracticus torquatus*

The Grey Butcherbird was common on the farming and urban edges of Gooseberry Hill, but was rare and did not nest in the undisturbed native vegetation of the central area.

Eggs were laid from late September to mid October (n = 4) and young fledglings were recorded as late as mid February (n = 1). One nestling colour-banded on 22 October 1986 was resighted 18 months later, 200 m from the nest. Growth curves for nestlings are shown in Figure 56.

Figure 56. Body mass and wing length for 3 nestling Grey Butcherbirds.

Australian Magpie *Gymnorhina tibicen*

Found throughout Gooseberry Hill, throughout the year. Sixty-eight of the records were for one pair of Magpies that were banded in January 1986 and were subsequently resighted every year thereafter until October 1988, when the female disappeared, and the male until January 1993 (7 years after banding) (Figure 57). Thirty-one (46%) of these sightings were made at carparks on the Zig Zag Road.

Nests were built from 1 August onwards; young fledglings seen mostly in October and November, latest 2 December.

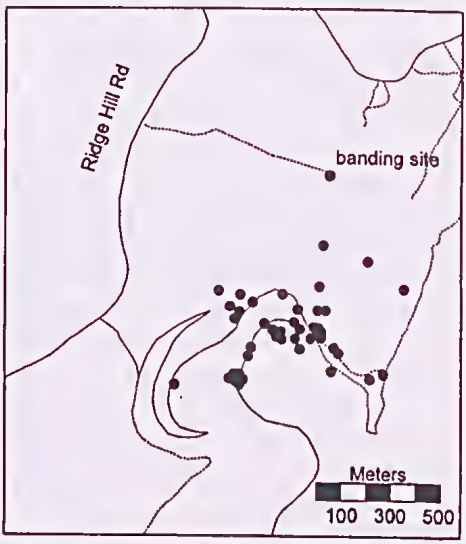

Figure 57. Locations where one pair of Australian Magpies were resighted, the male for 7 years after banding.

Unlike Australian Ravens (see below), magpies chased and harassed diurnal raptors throughout the year (Table 6).

Australian Raven *Corvus coronoides*

Ravens were common on all areas throughout the year. In January and February they formed flocks of up to 20 birds comprised mostly of juveniles. From late May to August noisy groups of 4 to 10 were seen flying apparently aimlessly. The composition of these groups was not ascertained and their purpose is unclear - Rowley (1973) recorded courtship flights but these involved only the resident pair.

Nest building was recorded as early as 22 June; earliest fledglings 16 September; latest fledglings 27 November. Most harrying by ravens of diurnal raptors (97%) occurred during the breeding season (August to November), despite the presence of raptors throughout the year (Table 6). Rowley (1973) reported a broader period for raptor harrying of Wedge-tailed Eagles near Canberra (April - September), although 77% of his records were for the main breeding season in that region (July to September).

Little Crow *Corvus bennetti*

Transit flocks of Little Crows were recorded by Serventy during the period 1957-1974. I. Rowley (pers. comm.) trapped 222 individuals near Midland between January 1972 and March 1974. The only record since then was of seven birds at Gooseberry Hill on 25 March 1987 (Smith 1987).

Richard's Pipit *Anthus novaeseelandiae*

Recorded on four occasions along road verges, once in June and September and twice in October.

Red-browed Finch *Neochmia temporalis*

Red-browed Finches were introduced to Western Australia unintentionally as aviary escapees and had become well established in the Kalamunda area by 1958 (Dell 1965). They were present on Gooseberry Hill and nested there in the late 1980s and early 1990s. A peak in numbers was recorded 1986 and 1987 following the major fire of 1985. After 1991, their numbers declined, with only one sighting since the 1994 fire up until August 1998, when several birds were seen on the northern edge of

Table 6. Numbers of raptors harried by Australian Magpies and Australian Ravens on Gooseberry Hill, 1984-1998.

harrying species	harried raptor	M	A	M	J	J	A	S	O	N	D	J	F
Australian Magpie	Little Eagle	1		1	1	1	3	8	3	3	1	1	
	Wedge-tailed Eagle	1				1							
	Square-tailed Kite							1					1
	Accipiter sp.		1	2				2	1			1	
	Total	2	1	3	1	2	3	11	4	3	1	2	1
Australian Raven	Little Eagle						7	18	10	5			
	Wedge-tailed Eagle					1	5	2	1		1		
	Square-tailed Kite						1	1					
	Accipiter sp.						2	4					1
	Total					1	15	25	11	5	1		1

Gooseberry Hill on four occasions. One possible cause of their decline could be trapping for aviculture. Seen most frequently along the Helena River or nearby (70% of records), occasionally all over Gooseberry Hill.

Nests were found in a variety of trees and shrubs (Appendix 3).

Three colour-banded individuals were resighted on the area 2, 11 and 33 months after banding.

Red-eared Firetail *Stagonopleura oculata*

Not seen on Gooseberry Hill until January 1988, although P. Hussey (pers. comm.) told me they were common along Helena River prior to the 1985 fire. Subsequently seen occasionally, but not in summer and rarely in the riverine habitats. One or more pairs were seen consistently in the central area during the winter and spring of 1997 and 1998 and most probably nested there.

Mistletoebird *Dicaeum hirundinaceum*

Most records from Gooseberry Hill were of birds in transit, probably because the high fire frequency had reduced the number of mistletoe plants on the area. An exception was the period March to July 1994, when they were seen taking fruit from mistletoe *Amyema preissii* growing on *Acacia saligna* on the northern edge of the area. Mistletoebirds were more frequently seen in suburbia and at the Lab, usually between February and August. At Marion Way, two adults were seen feeding a fledgling on 22 September 1993; and a female was observed feeding a young fledgling on 20 April 1998.

Welcome Swallow *Hirundo neoxena*

The Welcome Swallow is a regular late-autumn to early-winter visitor to Gooseberry Hill (Figure 58). The two

Figure 58. Number of records for Welcome Swallows on Gooseberry Hill, 1984-1998.

February records were made in 1985, soon after the fire of 30 January. At a small reserve surrounded by suburbia at Forrestfield, they were seen in all months of the year except February (Mawson and Massam 1995).

Tree Martin *Hirundo nigricans*

Recorded in all months foraging over all habitats. Nesting activity was recorded from August (building) to December (feeding nestlings). Tree Martins on Gooseberry Hill seem to favour nest hollows in Wandoos (9) rather than those in Marris (2). They also nested in *Eucalyptus rudis* along the Helena River.

Rufous Songlark *Cincloramphus mathewsi*

Recorded on 19 occasions in eight of 15 years. Most records were of single birds seen in December, January or February. Birds were seen outside these months only in the two years following the 1985 fire (Sept and Oct).

Silvereye *Zosterops lateralis*

The abundance of Silvereyes on Gooseberry Hill varied within and between years, although some birds were always present. They appeared to most numerous late-autumn to early-winter; least numerous in summer. They were present following fire, feeding on the resprouting foliage on eucalypts and shrubs such as *Dryandra armata*.

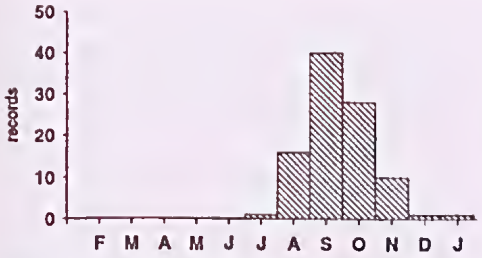

Figure 59. Distribution of 96 breeding records for Silvereyes on Gooseberry Hill, 1984-1998.

Nesting was recorded from 29 July (earliest) to 30 December (latest), with most nests and young recorded in September (Figure 59). Nests were built in Marri trees, Wandoos, vines and several species of shrubs (Appendix 3); median height above ground 1.0 m (n = 31); range 0.4 - 6.0 m. Growth curves for nestling Silvereyes are shown in Figure 60.

Silvereyes, along with Brown Honeyeaters, were observed taking nectar from *Watsonia* flowers by piercing the lower portion of the floral tube. Most flowers examined had a neat 5 mm slit near the proximal end.

A total of 190 adults and 75 nestlings were banded and 20 adults were retrapped at least once, all within 400 m of their banding site, up to 6 years later. Two banded in January 1991 were caught together at the same net line in July 1995.

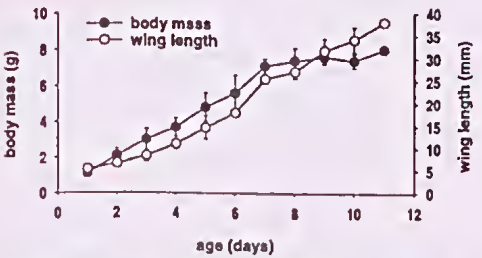

Figure 60. Body mass and wing length for known-age nestling Silvereyes (n = 1-8).

AVIARY ESCAPEES

Budgerigah *Melopsittacus undulatus*
One pale blue individual on Gooseberry Hill on 30 December 1985; one yellow bird at the Lab on 4 May 1992.

Canary
One light tangerine-coloured Canary on 18 September 1985.

Cockatiel *Nymphicus hollandicus*
One individual on 13 January 1991.

Crested Pigeon *Ocyphaps lophotes*
One individual in the old stables at the Lab on 23 May 1991.

Diamond Dove *Geopelia cuneata*
One individual near Helena River on 13 November 1994

Diamond Firetail *Stagonopleura guttata*
A pair of Diamond Firetails was seen on Gooseberry Hill on 8 December 1987. On 19 December a pair was seen feeding a fledgling (black bill, yellowish gape) in the same area. There were no further sightings of this species after 20 December. It seems likely that the pair (red bills) were escapees that bred in the wild.

Zebra Finch *Taeniopygia guttata*
Observed on two occasions, June 1988 and March 1989.

DISCUSSION

I recorded a total of 103 avian species, of which 12 were waterbirds. Eight of the 91 landbirds were introduced species, and a further seven were most probably aviary escapees. Although Dell (1983) lists 100 species for the Darling Scarp, there are considerable differences between the two lists. Of the species I

recorded at Gooseberry Hill, 22 were not on Dell's list and 18 species on his list were not seen on Gooseberry Hill. However, these discrepancies were mainly due differences in the numbers of waterbirds and vagrants.

I have no records for four species that I had expected, either because they had been previously recorded in the area or because the habitat appeared suitable- the Whistling Kite was recorded by Serventy as "not often seen"; the Australian Hobby might have been expected, although Serventy recorded it only twice in 16 years (June 1965, November 1971); Southern Emu-wrens are found on the scarp 5-10 km south of Gooseberry Hill in apparently similar habitat which is also frequently burnt. The scarp at Gooseberry Hill does not closely abut Swan Coastal Plain vegetation as it does further south (e.g. at Gosnells), which could explain, in part, the absence of emu-wrens from Gooseberry Hill; Little Crows were recorded by Serventy at the Knoll and were present in the Helena Valley-Midland area in the 1970s (I. Rowley pers. comm.). The only recent record for the area was by Rod Smith who saw seven on 25 March 1987 (WA Bird Notes 42: 3).

Forty-four species were recorded nesting on Gooseberry Hill and a further eight species probably did so. Of raptors, only the Brown Goshawk nested; the proximity of suburbia may have inhibited others such as Wedge-tailed Eagles.

For six species, the numbers of breeding birds on Gooseberry Hill usually increased in the year or years immediately post-fire (Little Button-Quail, Elegant Parrot, Yellow-rumped Thornbill, Red-capped Robin, White-winged Triller, Dusky Woodswallow). In other species (Fan-tailed Cuckoo, White-browed Scrubwren, Inland Thornbill, Western Thornbill, White-cheeked Honeyeater) the numbers breeding in post-fires years declined to just a few or none in the burnt areas.

A number of species that did not breed on Gooseberry Hill, foraged there - Short-billed Black-Cockatoos, Western Rosellas, Yellow-plumed Honeyeaters and Brown-headed Honeyeaters in some years; and Golden Whistlers, Grey Fantails and Welcome Swallows every year. None of these appeared to be affected by fire. However the frequent fires have probably contributed to the scarcity of Mistletoe on the area and the subsequent uncommon status of the Mistletoebird there.

The suite of sedentary species found today on Gooseberry Hill obviously cope with the high fire frequency of the present landscape. However, the long-term persistence of Splendid Fairy-wrens relies on the continued connectivity of the area to other similar habitat (Brooker and Brooker 1994a). The same scenario probably applies to the other heathland species.

Some species such as Western, Inland and Yellow-rumped Thornbills appear to be declining in numbers on Gooseberry Hill, although their densities have not fluctuated as much as for Splendid Fairy-wrens.

Two species which appear to have declined most markedly during the last 15 years are the Owlet- Nightjar (perhaps due to loss of hollows after the hot fires of 1985 and 1987) and the introduced Red-browed Finch (perhaps due to trapping for aviculture).

Another major factor that might affect the future survival of the Gooseberry Hill avifauna is the continuing spread of exotic plant species, such as watsonia (*Watsonia* spp.), which has the capacity

to become a monoculture in the species - rich gullies and winter-damp habitats.

Gooseberry Hill is of considerable scientific and intrinsic conservation value. Its scientific value lies in the existence of long-term datasets of faunal and floral abundances and distributions and fire history. Intrinsically, this area of the Darling Scarp represents the only major connection between the last large remnant of Ridge Hill Shelf landform (only 9% not alienated) and the forests of Kalamunda National Park.

POSTSCRIPT

Observations on Gooseberry Hill since 1998 have continued. Splendid Fairy-wren density remained static in 1999 (53 adults per 100 ha) and increased to 60.6 in 2000, which is about half the peak densities recorded in the mid 1980's (see Figure 20).

A hot fire deliberately lit on 20 December 2000 burnt about 60% of the study area.

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Appendix 1. Morphological measurements (wing = length of folded wing, maximum chord; tail = length of central rectrix; both measured to nearest 0.1 mm)

species	sex	body-mass (g)					wing (mm)					tail (mm)				
		n	mean	std	min	max	n	mean	std	min	max	n	mean	std	min	max
Horsfield's Bronze-Cuckoo	U	5	21.2	1.6	19.8	24.1	5	102.2	5.3	95	111	5	70.6	2.6	67	74
Shining Bronze-Cuckoo	U	6	22.6	1.0	21.1	24.0	7	105.4	3.5	101	111	6	67.7	3.1	64	74
Striated Pardalote	U	16	10.4	0.8	9.2	13.0	16	62.0	1.1	59	64	13	31.3	1.0	29.5	33
White-browed Scrubwren	F	11	10.5	0.5	9.6	11.4	11	50.9	1.6	49	55	11	45.3	1.9	42	49
	M	12	11.4	0.5	10.7	12.7	12	53.8	1.9	50.5	58	12	48.3	2.0	45	52
Weebill	U	10	5.6	0.3	5.0	6.0	10	49.1	1.3	47	51	8	33.9	1.0	32	35
Western Gerygone	U	9	6.1	0.4	5.0	6.8	9	55.9	1.4	54	59	9	43.6	1.3	42	45.5
Inland Thornbill	F	4	7.3	0.2	6.5	7.1	4	49.2	1.0	48	50	4	45.2	1.3	44	47
	M	4	7.3	0.2	7.0	7.6	4	52.0	0	52	52	4	47.4	0.8	46	48
Western Thornbill	U	308	7.01	0.41	6.0	9.3	298	47.75	1.63	44.0	52.5	215	35.9	1.8	32	47
Yellow-rumped Thornbill	U	41	9.16	0.43	8.2	9.9	40	58.16	1.72	55	61	35	40.6	2.0	37	45
Brown Honeyeater	F	9	9.39	0.63	8.4	10.7	9	58.6	1.7	55	60.5	7	45.6	3.7	40	50
	M	22	11.52	0.59	10.3	12.5	21	66.5	1.8	63.5	69.5	20	53.5	1.5	50	56
Tawny-crowned Honeyeater	F	8	15.9	0.7	15.0	17.0	8	72.8	1.1	71.5	75	7	59.4	3.0	55	64
	M	4	17.1	1.1	15.5	18.4	4	78.2	2.6	74	81	3	65.0	0.8	64	66
Western Spinebill	F	9	9.1	0.6	7.9	10.2	9	57.1	1.2	55	59	9	51.5	2.7	45	54
	M	23	10.7	0.9	9.3	12.5	23	61.5	1.8	58	65	20	56.5	2.2	53	60.5
Scarlet Robin	F	2	13.7	-	13.7	13.8	2	69.5	-	69	70	2	47.8	-	47	48
	M	7	12.4	0.7	11.5	13.6	7	71.3	1.4	69	73	7	50.6	2.2	47	54
Red-capped Robin	U	9	8.3	0.4	7.6	9.0	9	60.2	1.9	57	63	8	43.8	1.2	41.5	45
Rufous Whistler	F	2	26.2	-	25.4	27.0	2	91.0	-	90	92	2	67.0	-	65	69
	M	7	26.3	1.9	24.2	29.5	7	94.9	1.6	92	97	6	67.0	4.5	59	73
Grey Fantail	U	11	8.1	0.5	7.1	8.9	12	71.2	1.9	68	74	11	85.3	3.4	79	91
Willie Wagtail	U	4	20.2	1.4	18.6	21.7	4	97.5	3.2	93	101	4	104.0	3.4	99	108
Dusky Woodswallow	U	19	34.0	2.1	30.1	37.7	20	122.8	4.0	117	135	18	68.4	2.5	64	73
Red-browed Finch	F	3	10.4	0.6	9.5	11.0	3	50.5	1.5	48.5	52	3	43.8	2.7	41	47.5
Mistletoebird	M	5	10.0	0.8	8.9	11.2	4	63.0	0.7	62	64	3	29.8	0.8	29	31
Silvereye	U	62	9.35	0.5	8.3	10.9	42	55.0	1.6	52	60	41	43.7	1.8	40	48

Appendix 2. Egg measurements (egg volume calculated from measurements using the formula $V = 0.51\ L\ B^2$, where L is length, and B is breadth (Hoyt 1979)).

species	n	length (mm)				breadth (mm)				volume (ml)			
		mean	std	min	max	mean	std	min	max	mean	std	min	max
Little Button-quail	1	23.0	-	-	-	18.8	-	-	-	4.14	-	-	-
Fan-tailed Cuckoo	1	21.5	-	-	-	13.7	-	-	-	2.06	-	-	-
Horsfield's Bronze-Cuckoo	25	17.7	0.9	16.4	19.5	12.0	0.5	11.2	13.4	1.32	0.12	1.11	1.54
Shining Bronze-Cuckoo	14	17.7	1.0	15.5	19.4	12.4	0.6	11.5	13.5	1.39	0.19	1.04	1.72
Splendid Fairy-wren	79	16.4	0.5	15.6	18.0	12.4	0.4	11.6	13.3	1.34	0.10	1.15	1.56
Inland Thornbill	2	16.8	-	16.7	16.8	12.5	-	12.5	12.5	1.33	-	1.33	1.34
Western Thornbill	50	16.7	0.5	15.4	17.8	12.7	0.4	11.5	13.5	1.37	0.11	1.06	1.65
Yellow-rumped Thornbill	16	17.3	0.7	15.9	18.5	12.3	0.2	11.9	12.8	1.33	0.09	1.18	1.50
Brown Honeyeater	4	18.0	0.7	17.2	19.1	12.5	0.2	12.3	12.8	1.44	0.06	1.37	1.55
New Holland Honeyeater	6	21.0	0.7	19.9	21.8	15.1	0.4	14.7	15.9	2.45	0.19	2.19	2.69
Tawny-crowned Honeyeater	5	21.2	1.4	19.5	23.1	14.8	0.6	13.6	15.4	2.39	0.29	1.84	2.64
Dusky Woodswallow	2	23.6	-	23.4	23.8	17.0	0.4	16.5	17.4	3.46	-	3.25	3.67
Red-browed Finch	1	14.7	-	-	-	10.6	-	-	-	0.84	-	-	-
Silvereye	7	16.7	0.6	15.8	17.4	12.0	0.2	11.8	12.2	1.24	0.06	1.12	1.30

Appendix 3. Number of nests found in each plant species 1984-1998.

	Laughing Turtle-Dove	Galah	Splendid Fairy-wren	White-browed Scrubwren	Weebill	Western Gerygone	Inland Thornbill	Western Thornbill	Yellow-rumped Thornbill	Brown Honeyeater	White-cheeked Honeyeater	Tawny-crowned Honeyeater	Scarlet Robin	Grey Fantail	Dusky Woodswallow	Red-browed Finch	Silvereye
Pteridium esculentum							1			3							
Macrozamia riedlei			8							1							1
Tetrarrhena laevis			1														
Desmocladus sp.				1													
Kingia australis								3									
Xanthorrhoea preissii	1		9	3				236	17	7	3	1	9		2	3	3
Dioscorea hastiflora							1	3		1	1						6
Stypandra glauca			1														
Watsonia sp.										3							
Allocasuarina humilis			1					1				1					1
Dryandra armata			63					1		3	1	16					
Dryandra sessilis	1		2					1	8							1	
Dryandra nivea			1	2								1					
Grevillea bipinnatafida			1														
Grevillea endlicherana			2									6					
Grevillea pilulifera			1									1					2
Hakea cristata			23						6	1							
Hakea erinaceae			25	1			1										
Hakea incrassata			4														
Hakea lissocarpha			36	2			2	32	12	5	1	3				2	12
Hakea prostrata									1								
Hakea trifurcata			1							1							
Hakea undulata																2	
Isopogon dubius			5														
Petrophile biloba			1							1							
Synaphea acutiloba												2					
Synaphea pinnata										1							
Nuytsia floribunda								2	24				1		7	1	
Acacia pulchella			142				1			7	2						16
Acacia saligna			3						1							4	
Acacia sessilis			1														
Labichea lanceolata			1														
Daviesia horrida			16							1							
Nemcia spathulata			1														
Hovea pungens			1														
Jacksonia sternbergiana								1	1							1	
Lupinus sp.			2														

	Laughing Turtle-Dove	Galah	Splendid Fairy-wren	White-browed Scrubwren	Weebill	Western Gerygone	Inland Thornbill	Western Thornbill	Yellow-rumped Thornbill	Brown Honeyeater	White-cheeked Honeyeater	Tawny-crowned Honeyeater	Scarlet Robin	Grey Fantail	Dusky Woodswallow	Red-browed Finch	Silvereye
Trymalium ledifolium			1				1			1		1					5
Lasiopetalum bracteatum										1							
Hibbertia commutata										1							
Hibbertia hypericoides			6									2					
Thomasia foliosa			2														
Beaufortia purpurea			4							1		1					1
Calothamnus quadrifidus			63	2			3	1		1	1						1
Corymbia calophylla	2	3	8	1	1	7		58	76	7			10	3	21	3	6
Eucalyptus rudis		1				1			5					1			
Eucalyptus wandoo	1	10	13		6	1	1	32	60	1					7		5
Hypocalyma angustifolium			1														
Leptospermum erubescens			3				1										
Melaleuca radula			1														
Melaleuca rhaphiophylla	1						1	4	8	1				1		1	
Melaleuca scabra												1					
Leucopogon pulchella			2														
Hemigenia incana												1					
TOTAL	6	14	455	12	7	9	13	375	219	49	9	37	20	5	37	18	59

MAMMALS OF GOOSEBERRY HILL

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Since 1983, a record was made of the numbers and locations of any mammals encountered on Gooseberry Hill. In addition, observations made at the Lab and at Marion Way are included here, as are those made by Dom Serventy at the Knoll.

Echidna *Tachyglossus aculeatus*
Only two records of echidnas were made between 1984 and 1998, both of large specimens. However fresh diggings were seen occasionally, in particular along the main gully system.

Chuditch *Dasyurus geoffroii*
The only recent record of a Chuditch was made by Dom Serventy in December 1970.

Southern Brown Bandicoot *Isoodon obesulus*
Seen occasionally on Gooseberry Hill, at Marion Way and at the Lab. Most (10 of 14) road kills observed were between February and May. Single animals were regularly seen foraging during the day in leaf litter under wisterias and acacias at the Lab from February 1994 to January 1995, and in March and April of 1997. On 24 April 1994, two Black Rats *Rattus rattus* were present in the same area and chased the Bandicoot.

Brushtail Possum *Trichosurus vulpecula*
Not seen on Gooseberry Hill, but present throughout the year at Marion Way. Most animals could be individually identified by their colour (grey, brown, dark brown) and the presence and amount of white on the tail. A maximum of three was seen at the one time. In 11 years from 1988, breeding (juvenile on the back) was recorded 6 times (April and September 1988, August 1989, May 1990, October 1991, August 1993). There were five records of road-kills, four of them on Gooseberry Hill Road.

Black-gloved Wallaby *Macropus irma*
Serventy stated that Black-gloved Wallabies were "often seen" during his period of observation (1957-1974). For the period 1983 - 1998, there was only one possible sighting, in December 1984. They were recorded in heathland habitat on the Scarp at Lesmurdie (c. 10 km south of Gooseberry Hill) in May 1984 by Dell and How (1988). According to P. Christensen (in Strahan 1983) there was a major decline in Black-gloved Wallabies in Western Australia in 1973 and 1974. Serventy also stated that they eat the rinds of Zamia seeds *Macrozamia riedlei*. We have found chewed Zamia seeds in some years after fire, but this was not attributable to Black-gloved Wallabies.

Western Grey Kangaroo *Macropus fuliginosus*
Whenever Grey Kangaroos were encountered on Gooseberry Hill, their location and group size were recorded, and in most instances also the status

(size, age, breeding) of group members.

Grey Kangaroos were found throughout Gooseberry Hill in all months of the year. The median group size was two and the maximum 14, recorded in December 1996 (Figure 61). At least 16 different animals were seen on the 120 ha study area during the course of one day (3 October 1996).

The numbers of Grey Kangaroos seen between 1985 and 1998 are shown in Table 7. During the last four years in particular there was an increase in numbers and the size of groups. This latter period (1995 - 1998) was the only time that I have been bitten by ticks while walking through the area. There seems to be no obvious explanation (such as rainfall or fire) for the increase in Grey Kangaroo numbers. The security of the area changed when locked gates were erected in 1988. However there was no sign of hunting activities either before or after 1988 and all dead animals found were road kills.

Some blind animals were seen in November and December 1984 prior to the start of the "observation period". On three occasions, kangaroos were chased by dogs.

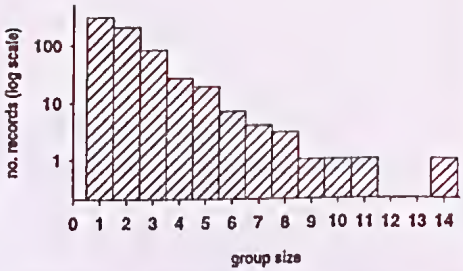

Figure 61. Size of groups of Western Grey Kangaroos seen on Gooseberry Hill.

Females with large pouch young were observed from August to January with peak sightings in October and November (70%, n = 44). Females with young at foot were seen mostly in December. Copulation was recorded in September, October and November.

Some kangaroos drank from horse troughs when the Helena River dried up in late summer. They selectively grazed species of *Lomandra* and *Haemodorum*, especially after fire.

Table 7. Numbers of Western Grey Kangaroos seen on Gooseberry Hill between 1985 and 1998.

Year	Number seen					Group size =>4
	large	medium	size not recorded	juvenile	total	(as % of total)
1985	10	3	19	1	33	3.8
1986	14	18	10	7	49	0
1987	19	34	17	24	94	8.0
1988	24	34	12	7	77	12.8
1989	25	30	13	14	82	6.5
1990	12	29	9	3	53	0
1991	12	20	9	4	45	0
1992	27	37	15	2	81	6.7
1993	28	31	20	4	83	2.0
1994	43	27	13	2	85	9.1
1995	34	82	32	14	162	15.5
1996	28	48	41	25	142	22.0
1997	28	115	6	11	160	13.7
1998	26	103	7	10	146	15.9

House Mouse *Mus musculus*

Several mice were trapped in invertebrate pitfall traps in May, June and October 1986 and June 1987 (Joe Leone, pers. comm.)

Rabbit *Oryctolagus cuniculus*

Rabbits were numerous in all habitats on Gooseberry Hill. There were no obvious year to year variations in numbers, although fewest were recorded in 1992, the wettest year recorded during the observation period.

Kittens were usually recorded from November to January. Several black colour variants were seen and myxomatosis-infected individuals were found in November 1988.

Fox *Vulpes vulpes*

Foxes were recorded on Gooseberry Hill on 24 occasions over 15 years with few (2) seen between April and June.Calls were heard in July (4 times) and March (once). Small pups were seen in November; half-grown juveniles in January. Two hungry-looking individuals were seen walking slowly down Marion Way in July 1990.

Cat *Felis catus*

There were 30 sightings of cats on Gooseberry Hill of at least 24 different individuals (based on the colour and pattern of their coat). Ten were within 100 m of houses; one was fitted with a collar; and two sightings were of a brown and white long-haired animal. Half of the animals seen were either black or black with some white markings. Most sightings were made between August and December (73%).

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PLANTS OF GOOSEBERRY HILL

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This paper is dedicated to Joanna Seabrook for her long-standing and tireless contribution toward the conservation of native plants in the Helena Valley and elsewhere in Western Australia.

INTRODUCTION

Vegetation studies on Gooseberry Hill were begun in 1983 and some of the results have been published in Brooker (1998). The aim of these early studies was, primarily, to measure structural features of the vegetation and the distribution of tree and shrub species - information that could be related to the biology of the bird species under study and the effects of wildfire on them. A reference collection was prepared, built on the pioneering work of Joanna Seabrook in the Helena Valley. In addition, the staff at the WA Herbarium and a number of local botanists helped with identification of plants in the collection, in particular Gwen Abbott, Lyn Atkins, John Marshall and Philip Reynolds.

Following the hot summer fire of 1994 (Table 1), the authors undertook censuses to measure the distribution of all vascular plants across the study area. Apart from sheer curiosity, the aim of this census was to obtain a spatial measure of plant species richness that can be measured only after fire. For example, three of the most frequently recorded native species (*Austrostipa macalpinei, Actinotus leucocephalus, Trachymene coerulea*) were rare on Gooseberry Hill except immediately after fire. Post-fire census data is therefore suitable for relating to topographic and disturbance parameters. Here we present a list of native species found on Gooseberry Hill and examine the effects of some environmental factors on the distribution of the more common species. An historic listing of plants found in the area of the Knoll is given in Hussey (1995) and introduced species found on the southern slopes of the western end of Helena Valley are listed by Hussey (1993). A more detailed examination of the occurrence of weed species is in preparation.

Since 1984, one author (PH) has kept detailed records of flowering period. Plant identification in this case was done with reference to Marchant *et al.* (1987) and checked for currency using the Western Australian Herbarium's Reference Collection and FloraBase. Voucher specimens have been lodged in the Western Australian Herbarium.

METHODS

CENSUS

Prior to censusing, transect lines were established between the 100 m grid markers. On all east-west and some north-south lines, 1106 census sites were permanently marked with a ribboned peg at 10 m intervals. On four occasions in 1994 (August, September, October and December) species present within 1 m of each peg were recorded.

From October to December 1995, the sites were revisited to record the presence of seeder trees and shrubs and to check anomolies from the 1994 census. All sites were visited once again in spring 1996 to census dodders which had not previously been identified to species level. Some early-flowering species that failed to persist until August could have missed - the only species we knew to have been overlooked in this way was the White Bunny Orchid *Eriochilus dilatatus*. Similarly, the occurrence of some species such as wurmbeas could have been underestimated, as would species with short periods of detectability such as *Pterostylis*. Lomandras were heavily and selectively grazed by kangaroos after fire, so their presence on some sites may have been overlooked.

Where there was doubt about the identification of a plant, a specimen was collected so that it could checked against the reference or by experts at the WA Herbarium. Even so, not all records could be positively ascribed to species. These included danthonias and some stipas. A collection of questionable *Lepidosperma* was identified to species level by Karen Wilson. This collection was used for field identification in the absence of a key for this genus.

Plants confined mainly to the north-south oriented gullies could have been under-represented on the east-west transects used, particularly *Chorizandra multiarticulata* and *Viminaria juncea*. *Grevillea manglesioides* was numerous on the river side of the area, generally north of the most northerly transect.

A number of site variables was measured. Aspect, altitude and gradient (Figure 61a,b,c) were obtained from an orthophotomap of the area provided by DOLA (see Figure 2). Soil classes (laterite, dolerite, granite) were based on the parent rock (Figure 63a,b,c). The

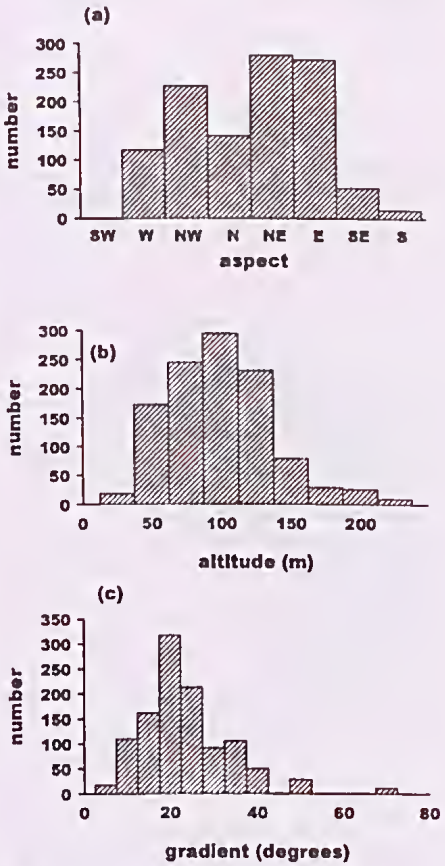

Figure 62. Distributions of (a) aspect, (b) altitude and (c) gradient on 1106 plant census sites

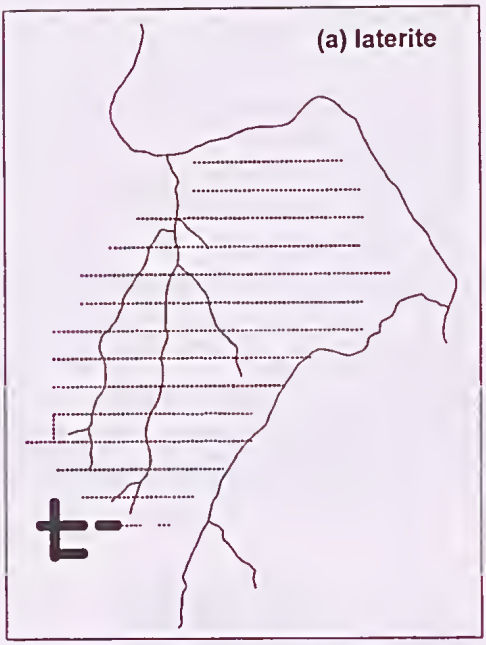

Figure 63. Distribution of soil types (a) laterite, (b) dolerite and (c) granite on Gooseberry Hill.

granite soil class included all types that were not lateritic or doleritic. It varied considerably in composition and depth. Fire history (Figure 64a,b,c) was obtained from maps of the burnt areas made immediately following each fire (see Brooker and Rowley 1991).

For common native species (found on 50 or more sites), relationships with some site variables were examined using generalised linear models (computer package GLIM; Baker and Nelder 1978). All involved multiple logistic regression, in which the error structure is assumed to be binomial and the data are logit transformed.

FLOWERING CALENDAR

Flowering period on the lower to mid slopes of the study area was recorded more or less monthly from 1984 to 1987. During 1988 - 1990, monthly traverses were undertaken which covered a wider area. These led to a publication on the distribution of

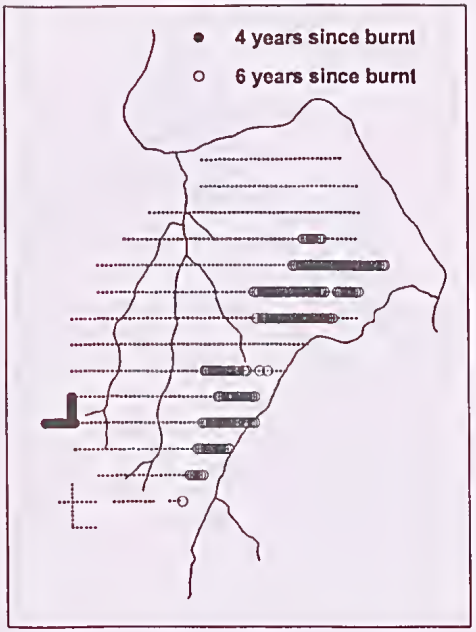

Figure 64. Fire history of Gooseberry Hill showing areas unburnt for (a) 4 and 6 years; (b) 7 years and (c) 9 years.

introduced plants (Hussey, 1993). Opportunistic recording has continued to the end of 1999. Thus, for most of the study area, detailed flowering records have been kept over a period of 11 years.

A species was recorded as flowering if, in a population, five or more plants had flowers/inflorescences, or an individual plant had 5 or more flowers/inflorescences. Fewer than this was not recorded. In the Appendix 4, two frequencies of flowering are noted. If the plants flowered in that month during the majority of the years in which they were recorded, eg in 8 or more years for common plants, this was given as the 'main' flowering period. Months in which some, but not all of the populations are in flower are listed as 'occasional'. Species which are less common, or those which flower most prolifically after a stochastic event such as fire, follow the same convention, but with fewer records on which to base the table.

RESULTS

CENSUS

A total of 491 plant species was recorded on Gooseberry Hill, of which 392 were natives and 99 introduced (Appendix 4). Overall, 80% of the species (393) were found on at least one of the 1106 census sites, as were 83% of the natives and 70% of the introduced species.

The number of sites on which each species was recorded ranged from 0 (18.9% of species) to 864 (0.2% of species), with a median of 11 sites per species (Figure 65).

The number of species per site varied from 0 to 55 (Figure 66) with a mean of 29.1 ± 7.8 and a median of 29.

Of the 393 species found on sites, 158 (40%) were recorded on laterite; 284 (72%) on dolerite; and 378 (96%) on granite. Thiry-five percent of species (139) were found on all three soil types.

Distribution maps and graphs for the common native species are given in Appendix 5. Of the 151 common species that occurred on 50 or more sites, 83 showed a significant difference in soil preference: - 21 mostly preferred laterite; 19 preferred dolerite; and 43 preferred granite. Other less common species (on <50 sites) that occurred

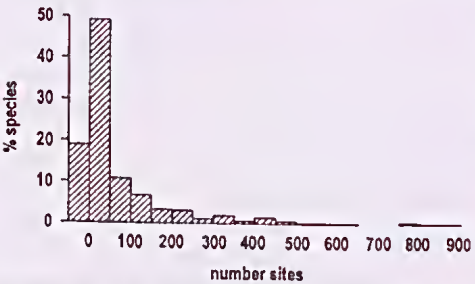

Figure 65. Frequency distribution of the number of sites each species was found on.

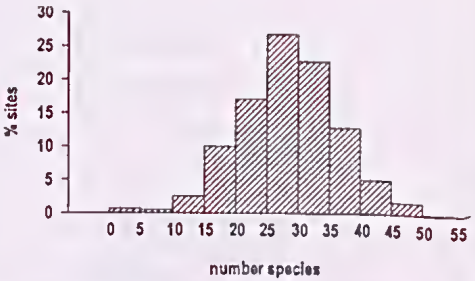

Figure 66. Frequency distribution of the number of plant species per site on Gooseberry Hill.

mostly frequently in laterite, included *Wurmbea tenella, Gahnia aff. 'aristata', Drosera leucoblasta, Scaevola calliptera, S. pilosa, Acacia nervosa, A. teretifolia, Calothamnus hirsutus, Eucalyptus marginata, Bossiaea ornata, Davesia cordata, Gompholobium preissii, Jacksonia restioides, Pultenaea ericifolia, Billardiera bicolor, Stylidium affine.* Two of the less common species (*Austrostipa elegantissima, Hakea myrtoides*) seemed to prefer dolerite.

Preference for aspect was determined by comparing west and north-west sites (n = 344) with all others; and east and north-east sites (n = 553) with all others. Seventeen species showed a significant preference for west-facing sites and 26 for east-facing sites (Appendix 4,5). There were insufficient south-facing sites for a north-south comparison.

With respect to gradient, a total of 22 species showed a significant preference

Table 8. The numbers of shrub species and non-shrub species (in parentheses) that showed a significant relationship with time since the previous fire.

Relationship	Resprouter	Seeder
positive	3 (7)	20 (6)
negative	13 (18)	1 (6)

for the steeper sites, while 25 species were found more often on flatter areas (Appendix 4,5).

It is interesting that for some species, their post-fire regeneration strategy was significantly related to time since fire (Table 8). Twenty-six of 33 obligate seeders had a positive relationship with time since the previous fire, while 31 of 41 resprouter species had a negative relationship (Appendix 4). There was a significant difference between seeders and resprouters in the proportions in each group (Table 8) (χ^2 = 21.5, d.f. = 1, $P < 0.001$); and for an expected 1:1 ratio within seeder shrubs ($P < 0.0001$, Warwick 1932); all seeders (P = 0.0006); and resprouter shrubs (P = 0.0105); but not all resprouters (P = 0.0601).

FLOWERING CALENDAR

Flowering phenology is given for 476 plant species (Appendix 4), of which 96 (20.2%) are introduced. The Papillionaceae (42 taxa), Asteraceae (40), Poaceae (38), Orchidaceae (31),

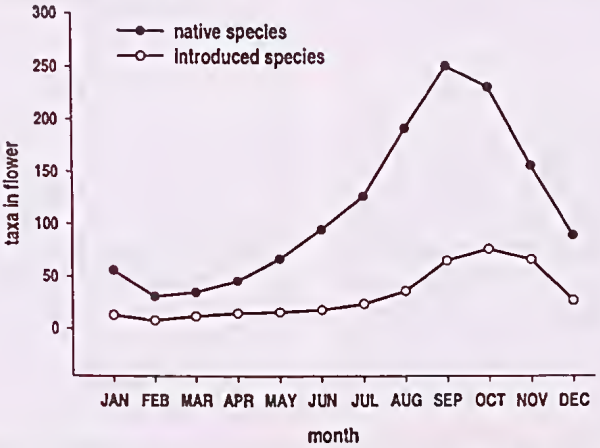

Figure 67. Number of native and introduced species flowering each month.

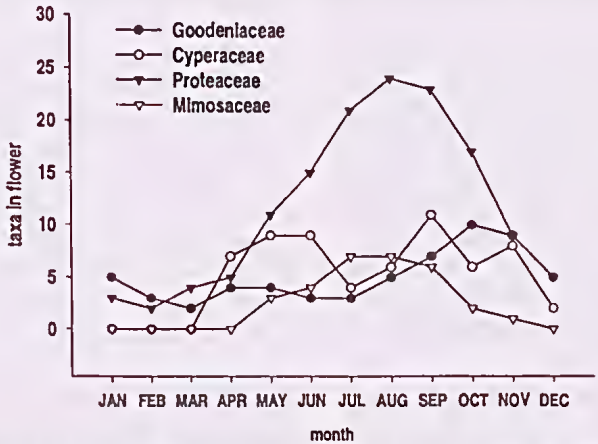

Figure 68. Number of species flowering each month in the Goodeniaceae, the Cyperaceae, the Proteaceae, and the Mimosaceae.

Proteaceae (29), Cyperaceae (23), Myrtaceae (23), Anthericaceae (19), Iridaceae (17), Apiaceae (14), Stylidiaceae (14), Droseraceae (11), Haemodoraceae (11), Goodeniaceae (10) and Mimosaceae (9) are the most species diverse families. Phenology was not recorded for 14 taxa known to be present, two being ferns, one a cycad, seven found only in or beside a small dam and four uncommon species.

The months in which flowering was observed are given in Appendix 4. Figures 67, 68 and 69 show the number of species recorded flowering each month.

DISCUSSION

A number of previous studies have reported on the plants of the Perth Hills area (Majer 1981, Worsley 1985, Armstrong & Muir 1994) or the Swan Coastal Plain (Milewski & Davidge 1980, Cranfield & Parker 1992). Of these, only Armstrong and Muir is directly comparable with this study. It was done in John Forrest National Park, some 10 km north, and 9 of its 22 sites lie on Churchward & McArthur's (1980) 'Darling Scarp' landform unit, within which the current study area lies. Armstrong & Muir reported on 587 species of plants over six years. Although this is a larger number of plants than the current study (491), it should be noted that they included sites in the 'Dwellingup' and 'Helena' units (Churchward & McArthur 1980). If elements of other units had been included in this paper (as was done in Hussey 1993) the total vascular plant species would be 609.

The long-term fire history of Gooseberry Hill has provided a unique opportunity to examine the effect of fire frequency on the occurrence of plant species.

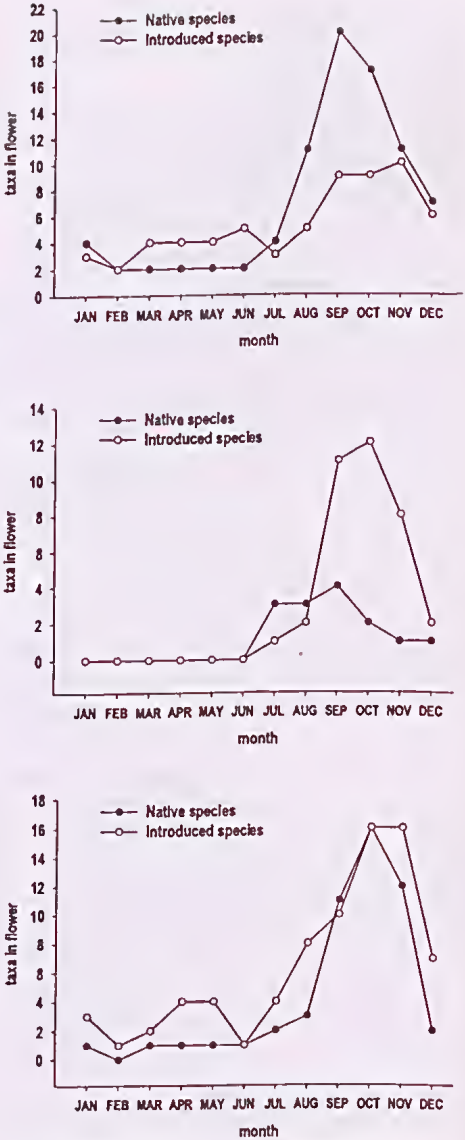

Figure 69. Number of species flowering each month in (a) Asteraceae, (b) Iridaceae and (c) Poaceae

One result of interest was the relationship where (a) seeders were more likely to be recorded the longer the time since the previous burn and (b) resprouters were more likely to be

recorded the shorter the time since the previous burn. Seeders may require time to build up a seed bank or, alternatively, may produce a larger seed bank, the longer the fire-free period. A similar explanation for resprouters is not so obvious, but could involve competition from seeders during long-unburnt periods.

The pattern of flowering produced by this study (Figure 67) is exactly similar to that given by Armstrong & Muir (1994), with a strong spring flush of growth, and introduced species peaking slightly later. This apparant homogeneity, however, houses considerable variation within and between families (Figure 68)

Mimosaceae and Proteaceae show the 'classic' pattern of a spring flush and summer quiescence. The flowering period presumably coincides with the maximum activity of pollinators, while seed production in spring-flowering plants will take place in late spring and summer, a peak period of activity for seed-collecting ants (Majer 1981)

Worsley (1985) shows a second, smaller peak in autumn/early winter and Armstrong & Muir (1994) hypothesise that this is an artifact of sampling. It is proposed here that such peaks could be produced by a preponderance of particular families. Cyperaceae has a pronounced peak in autumn - possibly this is an optimal period for wind pollination. Goodeniaceae peaks much later, and continues floristically active throughout the drier months. In late spring and early summer a number of blue-flowered members of this family come into bloom (*Goodenia caerulea, Scaevola glandulifera, S. pilosa* and *S. platyphylla*). The flowers have lighter centres and probably appear even more vividly coloured in the ultra-violet spectrum. Like most Goodeniaceae, they are designed for insect pollination. Blue-banded bees (family Anthophoridae, possibly from at least two species) are frequently observed working these flowers, and their upper surfaces become heavily dusted with pollen. It is possible that the plants might be very important in the life cycles of these native bees. The blue-flowered *Agrostocrinum scabrum* can also occasionally be found during these months, though its main flowering period is in spring, while the lilac flowered *Dichopogon capillipes* also flowers in summer. These are buzz-pollinated by blue-banded bees (Powell and Emberson 1996).

Several families contain introduced as well as native species, eg Asteraceae, Iridaceae and Poaceae. It would appear that the introduced species do not change the flowering pattern (Figure 69 a,b,c), so where fauna pollination is concerned, the introduced plants may be in direct competition with the natives. Note, it was expected that the grasses would show two distinct growth peaks, corresponding to C3 and C4 species, however this was not the case, as few C4 species occur in this area.

During the study, flowering was not recorded in 11 species: seven (*Alternanthera nodiflora, Hydrocotyle lemnoides, Chenopodium melanocarpum, Glinus lotoides, Melaleuca rhaphiophylla, Persicaria prostrata, Potamogeton crispus*), occur only in the dam, which was not searched regularly and four are uncommon species (*Gahnia aff. 'aristata', Amphibromus nervosus, Hypolaena* aff. *'viridis', Solanum linnaeanum*). No flowering was recorded in *Santalum acuminatum*, which is interesting. The populations are conspicuous, and the flowers were specifically searched for. This plant resprouts after fire, and Muir (1987)

records that *S. acuminatum* takes years to begin flowering. A further discussion of flowering and fire will be given in a forthcoming paper.

No population is now growing in an area that has more than seven year's of growth since being burnt, so presumably, the plants will eventually flower.

Seven species flowered in all months of the year. They were: *Agrostocrinum scabrum*, *Hypochaeris glabra*, *Euphorbia peplus*, *Goodenia fasciculata*, *Grevillea bipinnatifida*, *Solanum nigrum*, and *Tripterococcus brunonis*. Three are opportunistic weeds, and the others responded to fire, or heavy rainfall. If the same criterion as Armstrong & Muir's (1994) 'almost continuous' - ie. up to 2 months' gap - is used, the total rises to 17 and includes: *Sonchus oleraceus*, *Echium plantagineum*, *Hibbertia hypericoides*, *Stachys arvensis*, *Linum trigynum*, *Verticordia pennigera*, *Melinis repens*, *Themeda triandra*, *Grevillea manglesioides* and *Grevillea pilulifera*. Again, a high proportion are weeds, presumably responding to disturbance regimes.

Because a species is shown as having an extended flowering time, it does not mean that all plants are in flower throughout the length of that time. *Hibbertia hypericoides*, for example, flowers from March through to December, but in fact populations in warm, exposed sites flower earliest, while those in sheltered, more humid situations may come into bloom as much as three months later. This would give a wide range of opportunity to any pollinator dependant on this plant.

There are two principle climatic events which may lead to variations in flowering period, and one stochastic one:-

(a) topographic effect

The study area covers a vertical rise of 170m. It faces north, and so receives maximum insolation during the day. The low vegetation is no impediment to the passage of the frequent strong, drying easterlies or the sometimes moister westerlies. Higher in the landscape, and on exposed ridges, these forces will have greatest effect.

(b) orographic effect

As an elevated landform feature, the Knoll (see Figure 1) sometimes has low cloud which provides a small amount of extra precipitation to the upper sites. However, the top and eastern slopes of the central north-south ridge in the study area receive moisture from a cloud slug which moves down the valley from the two water supply dams upstream. At this point it hits the ridge and disperses, leaving the moisture it contained to sustain the wet granite meadows that are found on the eastern, but not the western side of the ridge.

(c) onset of first rains

Many species are keyed into action by a specific environmental event, the most obvious being the first heavy rains of autumn. *Drosera bulbosa* is a good example. Its flowers can burst out of the ground as little as 5 days after the rainstorm, as early as April or as late as June. *Stylidium repens* also responds similarly, it can flower heavily in summer, a week or so after a heavy storm. The same plant will flower again at the beginning of winter. *Dioscorea hastifolia* is also strongly controlled by the onset of the rains, but then secondarily influenced by topographic location, plants in shady areas coming into flower later than those in exposed sites.

Armstrong & Muir recorded seven species as having two periods of

flowering. Of the six which occur here, our records for five of them filled in the gaps; viz *Tricoryne elatior*, *Olearia paucidentata*, *Andersonia lehmanniana*, *Scaevola* (now *Goodenia*) *fasciculata* and *Lepidosperma angustatum* (now probably *L. tenue*). However, we recorded that *Laxmannia squarrosa* did not have a winter flush, but only flowered during spring and into early summer.

In addition, we found that *Goodenia caerulea* normally flowers in summer, but can have a smaller second flush in early winter. However, this does not occur in the year following a fire, when *G. caerulea* flowers most prolifically, but in subsequent years, as the main body of flowering in the population drops off.

CONSERVATION VALUE

Gooseberry Hill now has a considerable background of biological information, including extensive databases of the avifauna and flora (some of which are presented here), as well as a documented long-term fire history. Eight conservation priority plant species (*Pithocarpa corymbulosa*, *Senecio leucoglossus*, *Chorizandra multiarticulata*, *Acacia oncinophylla*, *Rinzia crassifolia*, *Nemcia acuta*, *Boronia tenuis*, *Lasiopetalum bracteatum*) and one declared rare fauna species (*Anthocercis gracilis*) occur there, as well as three of 10 Darling Scarp endemics listed by Heddle and Marchant (1983); viz, *Boronia tenuis*, *Synaphea acutiloba* and *S. pinnata*.

The area encompasses a full catena of Scarp landscapes, from riverine to lateritic cap-rock, with numerous granite outcrops, dolerite dykes and winter-wet herblands. Its inclusion in the adjoining Gooseberry Hill National Park would greatly enhance the diversity and conservation value of this existing park.

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Appeodix 4. Plant species recorded on Gooseberry Hill 1983 - 1999, showing (a) conservation code (Atkins 1999); (b) the number of sites each species was recorded on during the plant census (a blank indicates not recorded during census); (c) statistically significant results from GLM models relating species occurrences to environmental attributes (for the 3 soil types, a plus indicates the most preferred soil type; for aspect, E indicates a preference for E/NE over the rest and W indicates a preference for W/NW over the rest; for gradient and number of years since burnt previously, a plus indicates a significant positive relationship, a minus indicates a significant negative relationship); (d) ▼indicates distributioo map in Appendix 5; and (e) the flowering calendar (open squares indicate occasional flowering, filled squares indicate main flowering period). Species marked with an asterisk are introduced to Gooseberry Hill.

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	years since burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Adiantaceae																					
Cheilanthes austrotenuifolia		310	+				+	−	▼	phenology not recorded											
Cheilanthes distans		2								phenology not recorded											
Amaranthaceae																					
Alternanthera nodiflora										phenology not recorded											
Ptilotus declinatus		27											□	■	■						
Ptilotus drummondii		8											□	■	■						
Ptilotus esquamatus		52	+					−	▼				□	■	■	□					
Ptilotus manglesii		8												■	■	□					
Anthericaceae																					
Agrostocrinum scabrum		104			+		+	+	▼	□	■	■	■	■	■	■	□	□	□	□	□
Borya sphaerocephala		234		+					▼	□	■	■	□								□
Caesia occidentalis		199			+		+		▼		■	■	■	□							
Chamaescilla corymbosa		128				E			▼		■	■									
Dichopogon capillipes		74			+		+		▼			□	□	■	■	■	■	■	□		
Laxmannia ramosa		11																		■	
Laxmannia sessiliflora		30								■	■	□								□	■
Laxmannia squarrosa		223			+	E	+	+	▼			■	■	■							
Sowerbaea laxiflora		27										■	■								
Thysanotus dichotomus		8												■							
Thysanotus manglesianus		115					+		▼		□	■	■	□							
Thysanotus multiflorus		2									□	■	■	■	□	□					
Thysanotus scaber		20										■	■								
Thysanotus sp.		4																			
Thysanotus sparteus		56		+					▼				□	□	■	■	■	■	□		
Thysanotus tenellus		55					−	−	▼		■	■	■								
Thysanotus thyrsoideus		2											■								
Thysanotus triandrus												■									
Tricoryne elatior		87				W			▼				■	■	■	■	■	■	□	□	□
Tricoryne humilis		3										□	■	■	□						
Apiaceae																					
Actinotus leucocephalus		487							▼				□	■	■	■	□				
Daucus glochidiatus		10										■	■								
Eryngium pinnatifidum		8										■	■								
Homalosciadium homalocarpum		424	+			E		−	▼			□	■	□							
Hydrocotyle alata		2									■	■									
Hydrocotyle callicarpa		300	+			E			▼			■									
Hydrocotyle lemnoides										phenology not recorded											
Hydrocotyle pilifera		23											■								
Platysace juncea		9												□	■	■	■	□			
Trachymene coerulea		482			+	W	+	+	▼					■	■	■					
Trachymene pilosa		111	+			E			▼			■	□								
Xanthosia candida		239							▼		□	■	■	■							
Xanthosia pusilla		13										■	■								

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	years since burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Asteraceae																					
Arctotheca calendula *		55								○	■	■	■	■	■						
Asteridea pulvurulenta		303	+				+		▼		○	■	■	○							○
Brachyscome iberidifolia		11										■	■								
Brachyscome pusilla		2											■								
Conyza albida *		4																■	■		
Craspedia variabilis		1									■	○									
Crepis foetida *												■	■	■							
Dittrichea graveolens *		7																■	■		
Euchiton sphaericus		1											■								
Filago gallica *		8										■	■	○	○						
Helichrysum macranthum		1										■	■	○	○						
Hyalosperma cotula		197			+		−	−	▼			○	■	■	○						
Hyalosperma demissum		1										○	■								
Hypochaeris glabra *		198								■	■	■	■	■	■	■	■	■	○	○	■
Lagenifera huegelii		5									■	■									
Lawrencella rosea		38								○	■	■									
Millotia myosotidifolia		41								○	■	■									
Millotia tenuifolia		9										■									
Olearia paucidentata		60						−	▼	■	○			○		○	○	○	■	■	■
Pithocarpa corymbulosa	P2	9														■	○				
Podolepis gracilis		2										■	■								
Podolepis lessonii		311	+				−	−	▼		○	■	■	■	○						
Podotheca angustifolia		8										■	■								
Pseudognaphalium luteoalbum *		1												■	○						
Pterochaete paniculata		219			+				▼			○	■	○							
Quinetia urvillei		19										■	■								
Rhodanthe corymbose		322			+		+		▼			■	■	○	○						
Rhodanthe manglesii		2									○	■									
Senecio hispidulus		61					−		▼	○	○	■	■	■	■	○		○	○	○	○
Senecio leucoglossus	P4	3											■								
Senecio vulgaris *		1										■									
Siloxerus humifusus		47										■	■	■							
Siloxerus multiflorus		9									○	■									
Sonchus asper *		1										■	■	○						○	○
Sonchus oleraceus *		52								■	■	■	■	■	■		○	○	○	○	■
Tolpis barbata *		85								○	○	○	■	■	■	○				○	○
Trichocline spathulata		4											■	■	■						
Urospermum picroides *													■	■							
Ursina anthemoides *		206									■	■	■	○							
Waitzia suaveolens		54			+				▼				○	■	■	■	○				
Boraginaceae																					
Echium plantagineum *		28								○	■	■	■	■	■			○	○	○	○
Brassicaceae																					
Brassica tournefortii *											○	■	○								
Raphanus raphanistrum *		2								○	■										
Caesalpiniaceae																					
Labichea lanceolata		1								■	■	■	■	■	○	○		○		○	○

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	years since burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Campanulaceae																					
Wahlenbergia capensis *		1											■								
Wahlenbergia gracilenta		402				W	+	+	▼			■	■								
Caryophyllaceae																					
Cerastrium glomeratum *											□	□	■								
Petrorhagia velutina *		60										■	■	□							
Polycarpon tetraphyllum *													■								
Silene gallica *		183								□	□	■	■	□							
Spergula arvensis *										■	■										
Casuarinaceae																					
Allocasuarina huegeliana		11									□	■	■	□							
Allocasuarina humilis		97							▼	■	■	□						□	□	■	■
Centrolepidaceae																					
Aphelia drummondii		1									□	■	■	□							
Centrolepis aristata		75			+	W	−		▼			■	■								
Centrolepis drummondiana		119			+				▼		□	■	■								
Centrolepis glabra												■	■								
Chenopodiaceae																					
Chenopodium melanocarpum										phenology not recorded											
Colchicaceae																					
Baeometra uniflora *													■								
Burchardia multiflora		208		+			−	−	▼	■	■	□									■
Burchardia umbellata		211							▼	■	■	■									□
Wurmbea dioica		141	+			E	+	−	▼	■	■	■									□
Wurmbea pygmaea		28																			■
Wurmbea tenella		5								■	□										
Convolvulaceae																					
Convolvulus erubescens													□	■	■	□	□	□	□		
Crassulaceae																					
Crassula colorata		85	+				−	−	▼	■	■	■	□								■
Crassula decumbens		13								■	■	■	□	□							□
Crassula peduncularis											■										
Cyperaceae																					
Chorizandra enodis		1												■							
Chorizandra multiarticulata	P3	2										■									
Cyathochaeta avenacea		9											□	■	■						
Cyperus tenellus *												■	■	■							
Gahnia aff. 'aristata'		1								phenology not recorded											

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	years since burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Cyperaceae cont.																					
Isolepis congrua											■	■	□								
Isolepis cyperoides														■							
Isolepis marginata		364			+				▼		■	■	■	□							
Lepidosperma 'U3' (K. Wilson)		40			+		+	−	▼					□					□	■	□
Lepidosperma effusum		16												□					□	■	□
Lepidosperma leptostachyum		92		+				−	▼										□	■	□
Lepidosperma pubisquameum		100			+		−	−	▼											■	□
Lepidosperma tanue		208	+						▼	□		□							□	■	■
Mesomelaena pseudostygia																			□	■	□
Mesomelaena tetragona		47								□									□	■	■
Schoenus armeria		4									■										
Schoenus 'bravisetis'		7												■	■						
Schoenus grammatophyllus		92							▼	■	□	□							□	■	■
Schoenus nanus		3										■									
Schoenus odontocarpus		24										■	□								
Schoenus sculptus		3										■									
Schoenus subflavus		20										■	■								
Schoenus unispiculatus		39									■	■									
Tetraria octandra		81	+			E	−		▼	■	■	■	■	□						□	□
Dasypogonaceae																					
Calectasia cyanea												■									
Kingia australis		1									■										
Lomandra caespitosa												■									
Lomandra micrantha		8								■	■										
Lomandra nigricans											■										
Lomandra preissii		1								□									□	■	■
Lomandra spp.		6																			
Lomandra suaveolens		22																	□	■	□
Xanthorrhoea preissii		370				E		−	▼			■	■	■	□						
Dilleniaceae																					
Hibbertia aurea		83			+			+	▼	■	■	■	□	□					□	□	□
Hibbertia commutata		139	+			E		−	▼	■	■	■	■	□					□	□	□
Hibbertia hypericoides		327						−	▼	■	■	■	■	■	□			□	□	□	■
Hibbertia serrata										□	■	■	□								
Hibbertia spicata		103					+	−	▼		■	■	■	■	□						
Hibbertia subvaginata		130			+			+	▼		□	■	■	■	□	□				□	
Dioscoreaceae																					
Diosorea hastifolia		132	+			W	+	−	▼	□							□	□	■	■	■
Droseraceae																					
Drosera bulbosa		44							▼										□	■	■
Drosera erythrorhiza		115						−	▼												■
Drosera gigantea		13									■	■	■								
Drosera glanduligera		108			+		−		▼		■	■	■								
Drosera heterophylla		15								■	■	■									■
Drosera leucoblasta													■								

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	years since burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Droseraceae cont.																					
Drosera macrantha		85	+				+	+	▼	■	■	■	□							□	■
Drosera menziesii		438		+			–		▼		■	■	■								
Drosera pallida		114	+			E	+		▼		■	■									
Drosera platystigma		5									■	■	□								
Drosera stolonifera		145			+			+	▼	■											□
Epacridaceae																					
Andersonia eristata												■									
Andersonia lehmanniana		7								■	■	■	□			□		□	□	□	■
Astroloma ciliatum		2								■											■
Astroloma pallidum		59		+			+	–	▼	■	■	■				□	□	□	□	■	■
Leucopogon cymbiformis		14											□	■	■						
Leucopogon propinquus		3								□	■	□								■	
Leucopogon pulchellus		113			+			+	▼	■	■	■	□	□							
Lysinema ciliatum											■										
Euphorbiaceae																					
Euphorbia peplus *		2								□	□	□	■	■	■	■	■	□	■	■	□
Phyllanthus calycinus		118	+					–	▼	□	■	■	■	■	□						
Poranthera microphylla		68				E		–	▼			■	■	■							
Fumariaceae																					
Fumaria capreolata *		4								■	■	■	■	■				□	□	□	■
Fumaria muralis *		4									□	■	□	□							
Gentianaceae																					
Centaurium erythraea *		179												■	■	■	■		□		
Centaurium tenuiflorum *														■							
Cicendia filiformis *		8									□	■	■	□							
Geraniaceae																					
Erodium botrys *		142									■	■	■	■	□						
Goodeniaceae																					
Dampiera alata										□	■	■	■	■							
Dampiera linearis										■	■	■	■	■		□			□		
Goodenia caerulea		101		+		E		–	▼				■	■	■	■	□			□	□
Goodenia fasciculata		184			+	W			▼	□	■	■	■	■	■	■	■	□	□	□	□
Goodenia micrantha		74							▼			■	■	■							
Lechenaultia biloba		1									■	■	■	■							
Scaevola calliptera		1												■							
Scaevola glandulifera		27												■	■	■	■	□	□	□	□
Scaevola pilosa													□	■	■	■	■		□	□	
Scaevola platyphylla											□	■	■	■	□						
Haemodoraceae																					
Anigozanthos bicolor		47							▼	■	■	■	□								
Anigozanthos manglesii		3								□	■	■	■								
Conostylis androstemma		26								■											■
Conostylis setigera		58							▼	□	■	■	■								
Haemodorum brevisepalum		74			+	W	–		▼				■	■							

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	years since burnt	distribution map	flowering months: July	August	September	October	November	December	January	February	March	April	May	June
Haemodoraceae cont.																					
Haemodorum laxum		455							▼			■	■	■	■						
Haemodorum simplex		122		+					▼			■	■	■							
Haemodorum simulans		76			+			+	▼				■	■	■	■					
Haemodorum spicatum		53			+				▼				■	■	■	■					
Tribonanthes brachypetala		178					+		▼	■	■	■									
Tribonanthes longipetala		82			+				▼		■	■	■								
Haloragaceae																					
Glischrocaryon aureum														■							
Gonocarpus cordiger		145							▼			■	■	■	■	■					
Gonocarpus nodulosus		24										■	■								
Hypoxidaceae																					
Hypoxis occidentalis		101							▼	■	■										
Iridaceae																					
Babiana angustifolia *		6										■	■								
Freesia alba x leichtlini *		5									■	■	■								
Gladiolus caryophyllaceus *		325										■	■	■							
Gladiolus undulatus *		3										■	■	■	■						
Hesperantha falcata *		11										■	■								
Morasa flaccida *		94										■	■	■							
Orthrosanthos laxus		2								■	■	■	■								
Patersonia juncea		18								■	■	■									
Patersonia occidentalis		3								■	■	■	■	■	■						
Patersonia pygmaea												■									
Romulea rosea *		771								■	■	■	■								
Sparaxis bulbifera *		2										■	■								
Sparaxis pillansii *												■	■								
Watsonia marginata *													■	■							
Watsonia meirana *												■	■	■							
*Watsonia meirana var bulbilifera**												■	■	■	■						
Watsonia spp. *		25											■								
Watsonia versfeldii *												■	■	■							
Juncaceae																					
Juncus bufonius *		1										■	■								
Juncus capitatus *		13										■	■	■							
Juncus microcephalus *															■	■					
Juncaginaceae																					
Triglochin centrocarpa										■	■										
Lamiaceae																					
Hemiandra pungens		4									■	■	■								
Hemigenia incana		178			+				▼	■	■	■	■	■	■				■	■	■
Hemigenia sericea		31								■	■	■	■	■	■				■	■	■
Stachys arvensis *		13								■	■	■	■	■	■	■			■	■	■

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	burnt	distribution map	flowering months: July	August	September	October	November	December	January	February	March	April	May	June
Lauraceae																					
Cassytha glabella		31												■	■	■	■				
Cassytha pomiformis		141						+	▼		○	■	■	■	■	■					
Cassytha racemosa		12										■	■	■	■	■	○				
Linaceae																					
Linum marginale		1											■								
Linum trigynum *		68								○	○	■	■	■	■	■	○	○		○	○
Lobeliaceae																					
Isotoma hypocrateriformis		60					–	+	▼				■	■	■	■	○				
Lobelia heterophylla		40									○	■	○		■	■					
Lobelia rhombifolia																					
Lobelia rhytidosperma		239							▼				○	■	■						
Lobelia tenuior		1										■									
Monopsis debilis *												■	■	■							
Loganiaceae																					
Logania campanulata															○	■	○				
Loranthaceae																					
Amyema miquelii																		○	■	○	
Amyema preissii															■	■	■				
Nuytsia floribunda		13												■	■	■					
Malvaceae																					
Sida hookeriana		3											■								
Mimosaceae																					
Acacia alata		2								■	■										■
Acacia ericifolia										○										■	■
Acacia nervosa										■	■										
Acacia oncinophylla	P3	29									○	■									
Acacia pulchella		779					W	+	▼	○	■	■	■	○							
Acacia saligna		15									○	■	○								
Acacia sessilis		153				+	W	+	▼	■	■	○								○	■
Acacia teretifolia										■										○	■
Acacia willdenowiana		1								■	■	■									
Molluginaceae																					
Glinus lotoides *										phenology not recorded											
Myrtaceae																					
Baeckea camphoresmae		180						–	▼	○					■	■	■	■	■	○	○
Beaufortia purpurea		58					E	+	▼				■	■	○	■	■	○	○		
Calothamnus hirsutus										○	○				○	■	■	■	■	○	○
Calothamnus quadrifidus		411	+						▼		○	■	■	■	■						
Calothamnus sanguineus		32									■	○	○							○	■
Calytrix acutifolia		28											■	■							
Calytrix aurea		1													■						

	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Myrtaceae cont.																					
Calytrix glutinosa		1										■									
Corymbia calophylla		204							▼	□	□	□	□			■	■	■	■	□	
Darwinia citriodora		11								■	■	■	■	□						□	□
Darwinia thymoidas		3										■	■	□							
Eucalyptus marginata															■	■					
Eucalyptus rudis		1								■	■	■	■	■	□						□
Eucalyptus wandoo		9								□	□					■	■	■	■	■	□
Hypocalymma angustifolium		71				E	–	–	▼	■	■	■	■								□
Leptospermum arubescens		36								□	■	■	■	□							
Melalauca radula		2											■	■							
Malaleuca rhaphiophylla										phenology not recorded											
Malalauca scabra		301		+			–	+	▼	□	□	■	■	■	□						
Rinzia crassifolia	P4	1								□	■	■	■	□							□
Verticordia acerosa		17								□	■	■	■								
Verticordia densiflora		28											□	■	■						
Verticordia huegalii		12									■	■	■	■							
Verticordia pennigara		7								□	□	■	■	■	■	■			□	□	□
Orchidaceae																					
Caladenia flava		13									■	□									
Caladenia longicauda		7										■									
Caladenia marginata		3										■									
Caladenia reptans		6									■										
Caladenia varians		40								■											
Cyanicula daformis		177					–	–	▼	■	□										
Cyanicula gemmata		240						+	▼		■	■									
Diuris brumalis		3								■	■										□
Diuris corymbosa		9										■	■								
Diuris laxiflora												■									
Diuris setacea												■	□								
Elythranthera brunonis												■									
Elythranthera emarginata		4										■	■								
Erlochilus helionomos										□											■
Microtis atrata		10											■								
Microtis media		3										□	■	■							
Monadenia bracteata *													■	■							
Prasophyllim elatum		12										■									
Prasophyllum fimbria		29								■											□
Prasophyllum hians												■									
Prasophyllum parvifolium											■										
Prasophyllum plumaeforme											■										
Prasophyllum ringens		20								□	□	■	■								
Pterostylis sanguinea											■										
Spiculaea ciliata		1												■	■	□					
Thelymitra antennifara		1								□	■	■	■								
Thelymitra benthamiana												■	■								
Thelymitra crinata		3										■	■								
Thelymitra flexuosa		2									■	■									
Thelymitra macrophylla		3										■	■								
Thelymitra pauciflora		1											■								

	conservation code	no. atlas recorded on	laterite	dolerite	granite	aspect	gradient	burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Orobanchaceae																					
Orobancha minor *		5										■	■								
Oxalidaceae																					
Oxalis comiculata *		12								□	■	■	■	■				□			□
Oxalis glabra *		1								■	■									□	■
Oxalis pes-caprae *										■	■	■	■	□						□	■
Papilionaceae																					
Bossiaea ornata												■									
Chorizema dicksonii		10								□	■	■	■	□							
Cytisus prolifarus *		1									■	■									
Davesia cordata											■	■	■	■							
Davesia decurrens		2								■											■
Davesia hakeoides		9								■											
Davesia horrida		154		+				-	▼	■	■	■	■	□							■
Davesia polyphylla		9								□	■	□									□
Gompholobium aristatum		17										□	■	■	□						
Gompholobium marginatum		239						+	▼	□	■	■	■	■	□						□
Gompholobium polymorphum		9									□	■	■	■							
Gompholobium preissii													■	■							
Gompholobium shuttleworthii		53				E		-	▼				■	■							
Hovea chorizemifolia										■	■									□	■
Hovea pungans		92			+			+	▼	■	■	□	□								■
Hovea trisperma		53			+				▼	■	■	■	□								□
Isotropis cuneifolia		55			+			+	▼	□	■	■									□
Jacksonia alata		8								□	■	■	■	□							
Jacksonia restioides												■	■	■	■	□					
Jacksonia stemberglana										□		■	■	■	□			□			
Kennedia coccinea		6									■	■	■	□							
Kennedia prostrata		5								□	■	■	□	□							□
Kennedia stirlingii		30									■	■	■	□							
Lotus angustissimus *		1											■	□							
Lotus suaveolens *		30										■	■	□							
Lupinus angustifolius *		8										■	□								
Mirbelia ramulosa		22								□	■	■	■	□							
Mirbelia spinosa		23									■	■	■								
Nemcia acuta	P3	47									■	■	■								
Nemcia capitata		44								■	■	■	■								□
Nemcia spathulata		387		+		W		+	▼	□	■	■	■								
Pultenaea ericifolia												■	■								
Sphaerolobium medium		15										■	■								
Templetonia biloba		41								■	□									□	■
Trifolium angustifolium *		2											■	■							
Trifolium arvense *		1											■	■							
Trifolium campestre *		134								□	■	■	■	■	□						□
Trifolium dubium *		15									□	■	■	□							
Trifolium glomeratum *		6										□	■	□							
Trifolium subterraneum *		59								□	■	■	■	□							□
Trifolium tomentosum *												■									
Viminaria juncea		1												■	■	■					

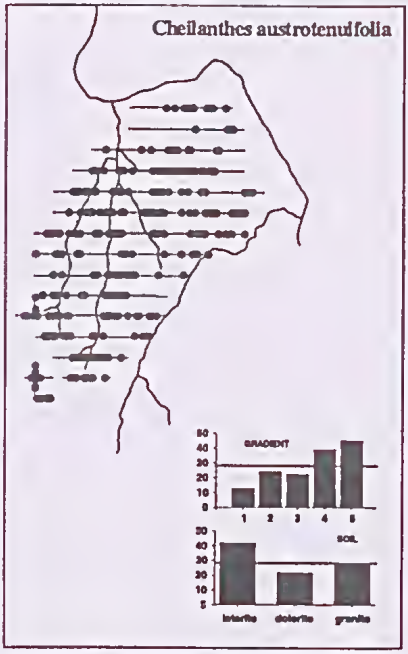
	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Philydraceae																					
Philydrella pygmaea		12										■									
Phormiaceae																					
Dianella revoluta		4												■	■						
Stypandra glauca		97	+					−	▼	■	■	■	■	■							
Phytolaccaceae																					
Phytolacca octandra *										□	■	□									
Pittosporaceae																					
Billardiera bicolor		1													■	■	■	■			
Billardiera drummondiana										□	■	■	■	□							
Pronaya fraseri															■	■	■	□			
Poaceae																					
Aira caryophyllea *		812										■	■	■							
Amphibromus nervosus										phenology not recorded											
Amphipogon strictus		138		+				−	▼			□	■	■							
Aristida holothera		2										■	□								
Austrodanthonia caespitosa												■	■	■							
Austrodanthonia semiannularis																					
Austrodanthonia spp.		301							▼												
Austrostipa campylachna													■								
Austrostipa elegantissima		28									□	■	■	□							
Austrostipa macalpinei		864			+	E	−	−	▼				■	■							
Austrostipa semibarbata												□	■	■							
Austrostipa spp.		177							▼												
Austrostipa tenuifolia												□	■	■							
Avena barbata *		194									□	■	■	■	□				□		
Brachypodium distachyon *		32								□	□		■	■					□	□	□
Briza maxima *		507								□	■	■	■	■							
Briza minor *		617									□	■	■	■							
Bromus hordaceus *		3											■	■							
Bromus rubens *		1											■								
Cymbopogon obtectus		1												■	■						
Cynodon dactylon *													■	■							
Deyeuxia quadriseta		69						−	▼				■								
Dichelachne crinata		6											■								
Ehrharta calycina *		36									■	■	□	■	□						
Ehrharta longiflora *		12								□	□	■	■	■	■	□				□	
Eragrostis curvula *		2										□	■	■	■	□	□	□	□	□	
Eragrostis elongata												■	■								
Lolium rigidum *		3											■	□							
Melinis repens *										■	■	■	■	■	■	□		□	■	■	■
Microlaena stipoides		9											■	□	□						
Neurachne alopecuroidea		445		+		E			▼	□	■	■	■	□							
Paspalum dilatatum *														■	■						
Paspalum urvillei *														■							

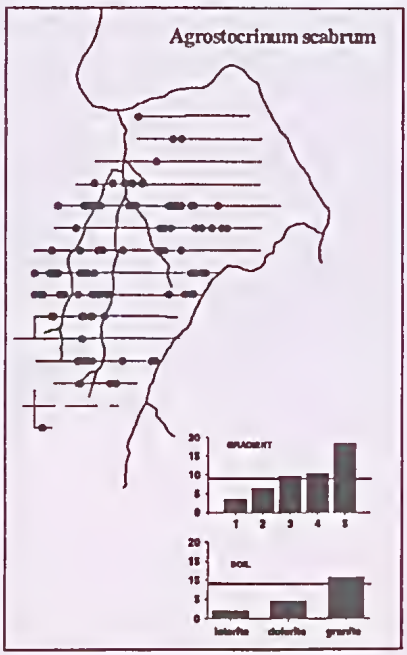
	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Poaceae cont.																					
Pentaschistis airoides *		107										■	■								
Poa annua *											■										
Poa drummondiana		29										■	■	□							
Polypogon monospeliensis *		1												■	■						
Tetrarrhena laevis		16										□	■	□							
Themeda triandra		15								■	■	■	■	■	■	□		□	□	□	■
Vulpia bromoides *													■								
Vulpia myuros *		316										■	■	■							
Polygalaceae																					
Comesperma calymega		25											■	■	■	□		□	□	□	□
Comesperma ciliatum		6									□	■	■	■							
Polygonaceae																					
Muehlenbeckia adpressa		1									□	□	■	■							
Persicaria prostrata										phenology not recorded											
Portulacaceae																					
Calandrinia corrigioloides		51			+				▼		■	■									
Potamogetonaceae																					
Potamogeton crispus *										phenology not recorded											
Primulaceae																					
Anagallis arvensis *		241									□	■	■	■	■	□	□		□		□
Proteaceae																					
Banksia grandis														■							
Conospermum huegelii		56						+	▼		■	■	■								
Dryandra armata		101				E	−	−	▼	■	■	□	□							□	■
Dryandra nivea		300				E		−	▼	■	■	■	■	□							
Dryandra sessilis		22								■	■	■	□								□
Grevillea bipinnatifida		68							▼	■	■	■	■	■	■	■	■	■	□	□	■
Grevillea endlicheriana		56				W	+	−	▼	■	■	■	■	■	□	□				□	□
Grevillea manglesioides										■	■	■	■	■	■	□		□	□	□	□
Grevillea pilulifera		444							▼	■	■	■	■	■	□		□	□	□	□	■
Grevillea synaphaea										□	■	■									
Hakea cristata		15								■	□									□	■
Hakea erinacea		170						+	▼	■	■	■	■						□	□	■
Hakea incrassata		93	+					−	▼	■	■	□									■
Hakea lissocarpha		122	+					−	▼	■	■	■									■
Hakea myrtoides		15								■	□									□	■
Hakea petiolaris		10								■	□									□	■
Hakea prostrata										□	■										
Hakea stenocarpa		16										■									
Hakea trifurcata		141			+			+	▼	■	■	■									
Hakea undulata		102			+			+	▼			■	■								
Isopogon asper		24								■	■	□									■
Isopogon divergens		2								□	□	■									
Isopogon dubius		92		+		W	−	+	▼	■	■	■	□								

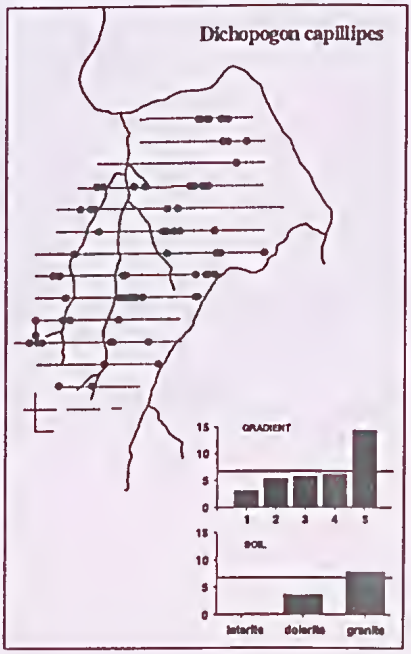
	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Proteaceae cont.																					
Persoonia angustiflora		4											■	■	□						
Petrophile biloba		156			+	W		+	▼	■	■	■	□							□	□
Petrophile seminuda		21									□	■	■	□							
Petrophile striata		9										■	■								
Synaphea acutiloba		307			+			+	▼	■	■	■	■	■				□	□	□	■
Synaphea pinnata		25									□	■	■								
Restionlaceae																					
Desmocladus fasciculatus		13									■	■	□								
Desmocladus sp.		282		+			+	−	▼		□	■	■								
Hypolaena aff. 'viridis'		1								phenology not recorded											
Lepidobolus praisslanus		69		+		W			▼		■	■	■								
Lepyrodia macra		2													■						
Rhamnaceae																					
Cryptandra arbutiflora		12								■	■									□	■
Cryptandra nutans		4								■	□									□	■
Stenanthemum notiale		30												■	■	□		□			
Trymalium floribundum		7								□	■	■	■	□							
Trymalium ledifolium		413				W	+	+	▼	■	■	■									■
Rosaceae																					
Acaena echinata *												■									
Rubiaceae																					
Galium divaricatum *		83										■	■	■							
Opercularia vaginata		125		+					▼	□	■	■	■	■							
Rutaceae																					
Boronia cymosa		6								□	□	■	■	■							
Boronia ovata		4									□	■	■	■							
Boronia ramosa		3								■	■	□	□	□							□
Boronia tenuis	P4	6									■	■									
Philotheca spicata											■										
Santalaceae																					
Santalum acuminatum		1								never found in flower											
Sapindaceae																					
Diplopeltis huegelii		107			+	W	+	+	▼	□	■	■	■	□				□		□	□
Scrophulariaceae																					
Bartsia trixago *		595											■	■	■						
Misopates orontium *		67										■	■	□							
Parentucellia latifolia *		119										■	■								
Perentucellia viscosa *		34										■	■	■							
Solanaceae																					
Anthocercis gracilis	DRF	4										■									
Nicotiana rotundifolia		7											■								
Solanum linnaeanum *		2								phenology not recorded											
Solanum nigrum *		3								■	■	■	■	■	■	■	■	■	■	■	■

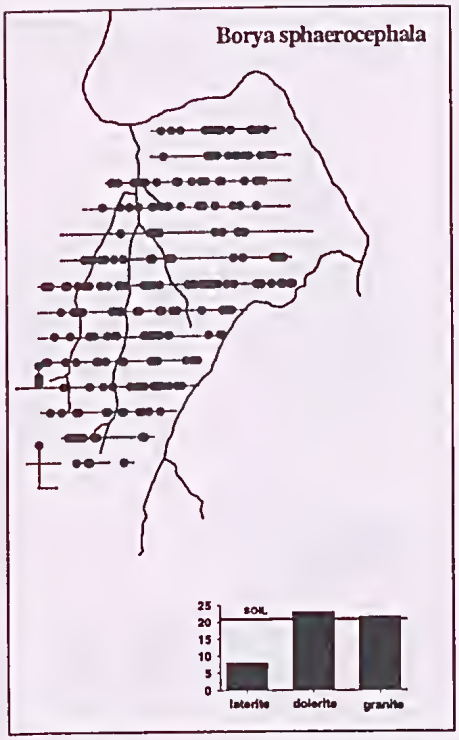
	conservation code	no. sites recorded on	laterite	dolerite	granite	aspect	gradient	burnt	distribution map	flowering months											
										July	August	September	October	November	December	January	February	March	April	May	June
Stackhousiaceae																					
Stackhousia monogyna		9									■	■	■								
Tripterococcus brunonis		239			+	E	−	+	▼	■	■	■	■	■	■	■	□	□	□	□	□
Sterculiaceae																					
Guichenotia sarotes		1									■	■	■								
Lasiopetalum bracteatum	P4	17										□	■	■	□						
Rulingia cygnorum		7									□	■	■	□							
Thomasia foliosa		19								■										■	■
Thomasia glutinosa		23									□	■	■	■	■	□					
Stylidiaceae																					
Levenhookia pusilla		48	+			E			▼				■	■	□						
Levenhookia stipitata		297			+				▼					■	■						
Stylidium affine											■	■	■	□							
Stylidium brunonianum		108				E			▼				■	■	■						
Stylidium bulbiferum		260				W			▼				■	■	■						
Stylidium calcaratum		210			+	E	+		▼		■	■	■								
Stylidium carnosum		1										■									
Stylidium dichotomum		91			+		−	+	▼				■	■	■						
Stylidium ecorne		14										■									
Stylidium hispidum		66					−	+	▼		□	■	□								
Stylidium petiolare		20										■	■								
Stylidium pubigerum		38											■								
Stylidium pycnostachyum												■	■								
Stylidium repens		53			+	E	−	+	▼	□				□	□	□	□	■	■	■	■
Thymelaeaceae																					
Pimelea argentea		8									■	■	■	□							
Pimelea ciliata		32										■	■								
Pimelea imbricata		170			+			+	▼			■	■	■	□						
Tremandraceae																					
Tetratheca hirsuta		27										■	■	□							
Tetratheca nuda		1										■	■	□							
Typhaceae																					
Typha orientalis *															■						
Urticaceae																					
Parietaria debilis													■								
Violaceae																					
Hybanthus floribundus										■											□
Zamiaceae																					
Macrozamia riedlei		47							▼	phenology not recorded											

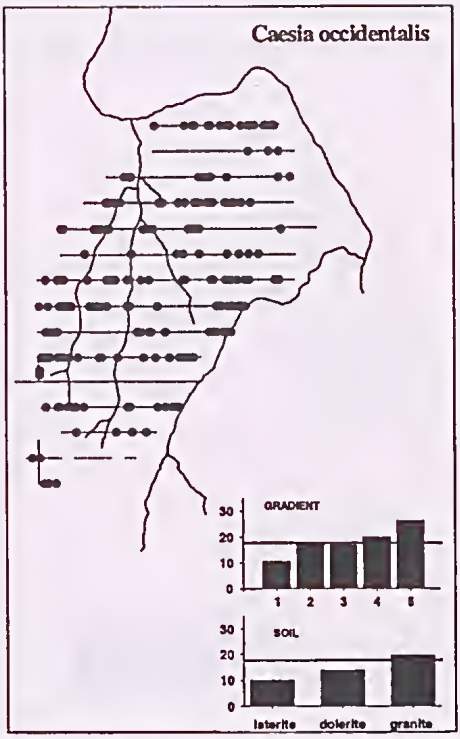
Appendix 5. Distribution maps and graphs for some of the more common native species on Gooseberry Hill (i.e. those recorded on 50 or more sites). Grid lines on the maps represent the distribution of sampling sites, placed 10m apart along transect lines 200m apart. Histograms represent the percentage of sites on which the species was recorded. Horizontal lines on graphs indicate the expected percentages.

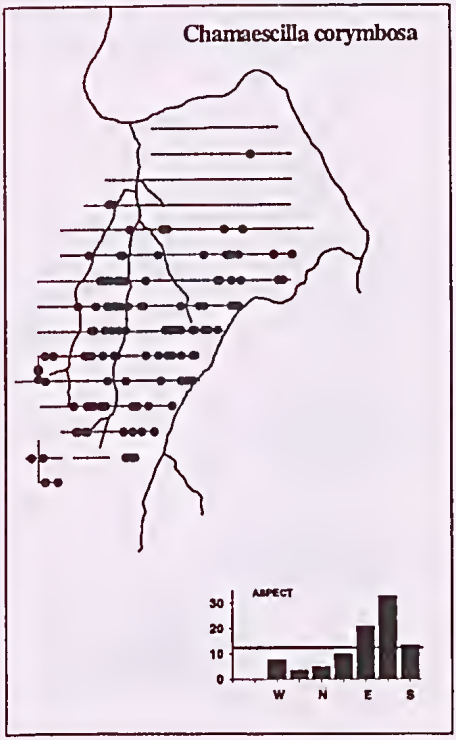


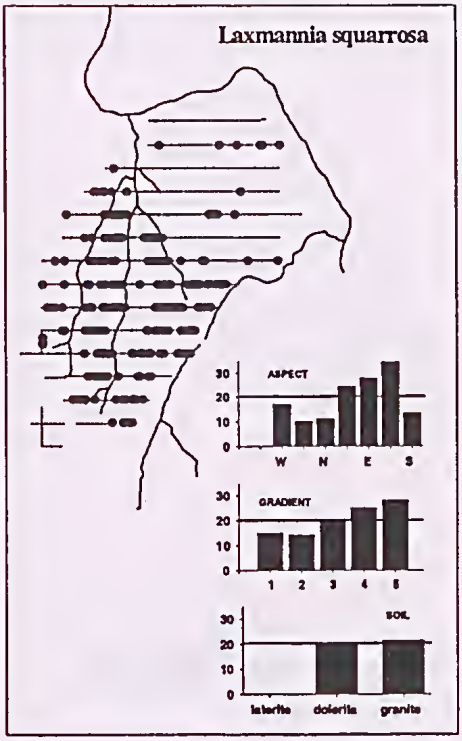





Borya sphaerocephala
SOIL
25
20
15
10
5
0
laterite
dolerite
granite


Caesia occidentalis
GRADIENT
30
20
10
0
1
2
3
4
5
SOIL
30
20
10
0
laterite
dolerite
granite

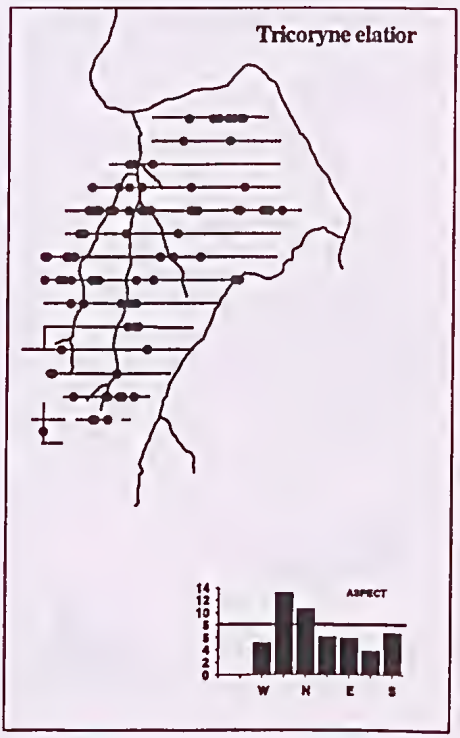

Chamaescilla corymbosa
ASPECT
30
20
10
0
W
N
E
S

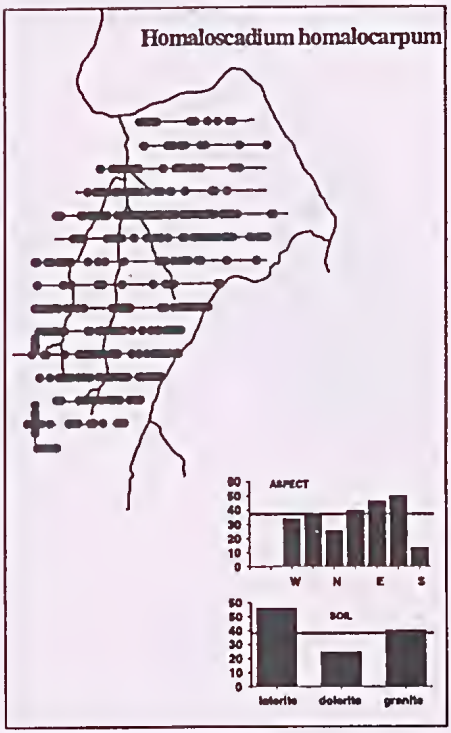

Laxmannia squarrosa
ASPECT
30
20
10
0
W
N
E
S
GRADIENT
30
20
10
0
1
2
3
4
5
SOIL
30
20
10
0
laterite
dolerite
granite

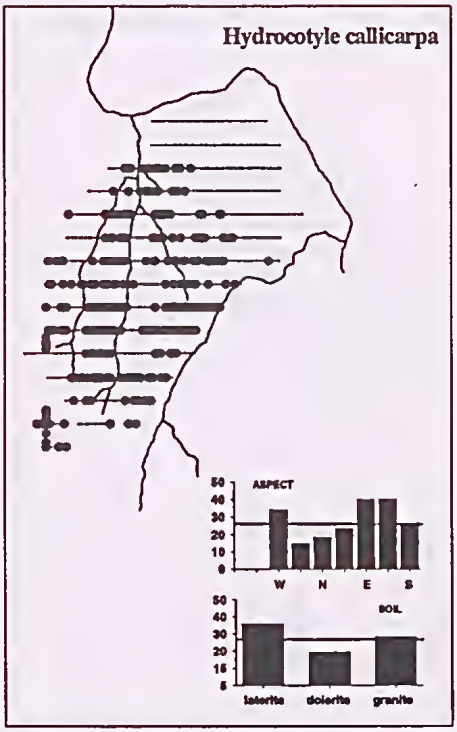
Thysanotus manglesianus
GRADIENT
15
10
5
0
1 2 3 4 5

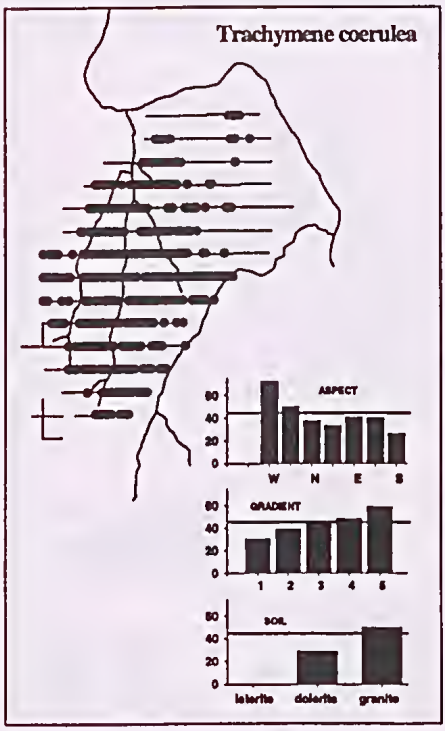
Thysanotus sparteus
SOIL
12
10
8
6
4
2
0
laterite
dolerite
granite

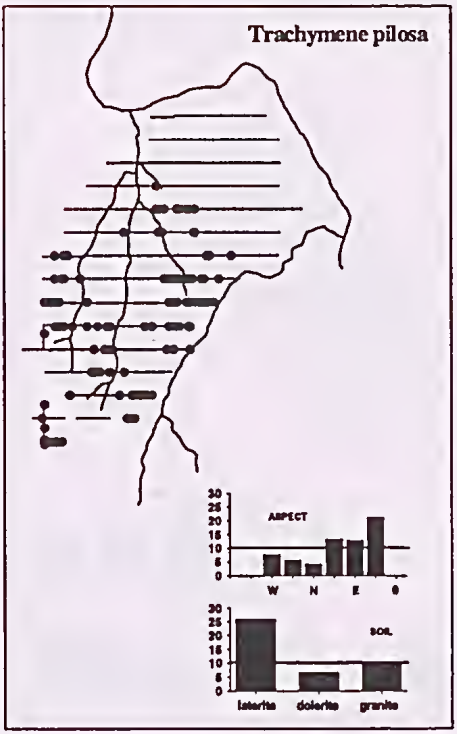
Thysanotus tenellus
GRADIENT
10
8
6
4
2
0
1 2 3 4 5

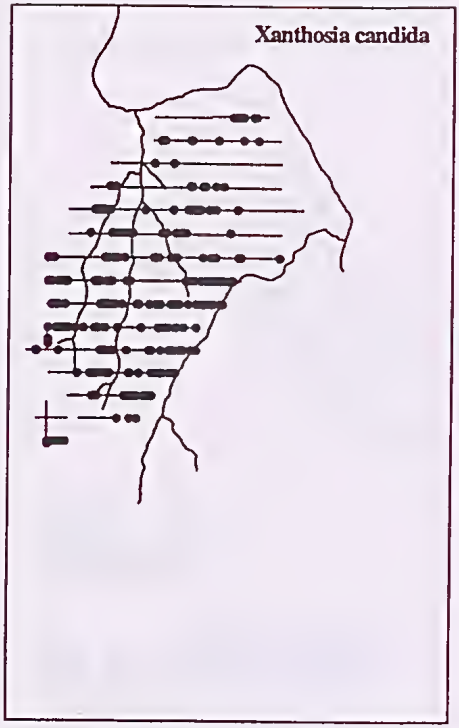

Tricoryne elatior
ASPECT
14
12
10
8
6
4
2
0
W N E S


Homaloscadium homalocarpum
ASPECT
W N E S
SOIL
laterite dolerite granite

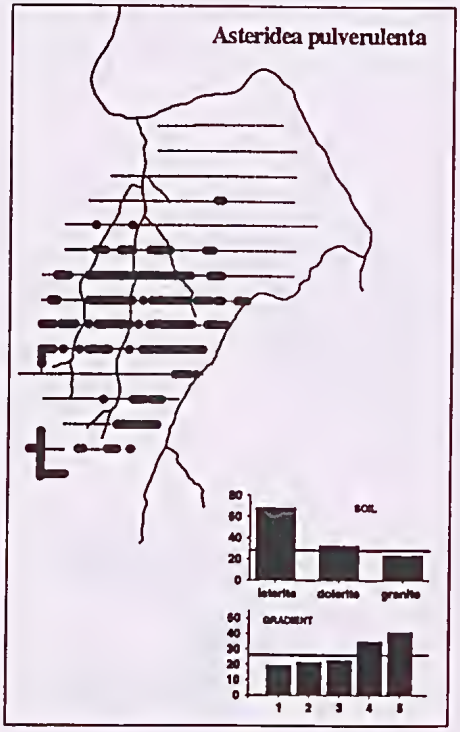

Hydrocotyle callicarpa
ASPECT
W N E S
SOIL
laterite dolerite granite


Trachymene coerulea
ASPECT
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite


Trachymene pilosa
ASPECT
W N E S
SOIL
laterite dolerite granite


Xanthosia candida

Actinotus leucocephalus


Asteridea pulverulenta
SOIL
laterite
dolerite
granite
GRADIENT
1
2
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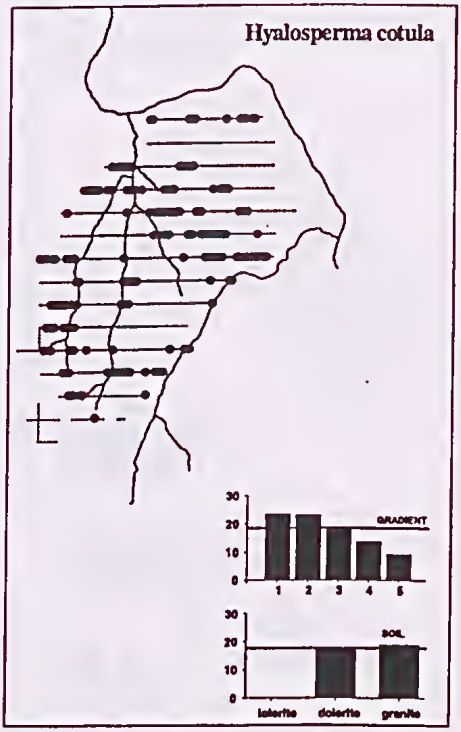
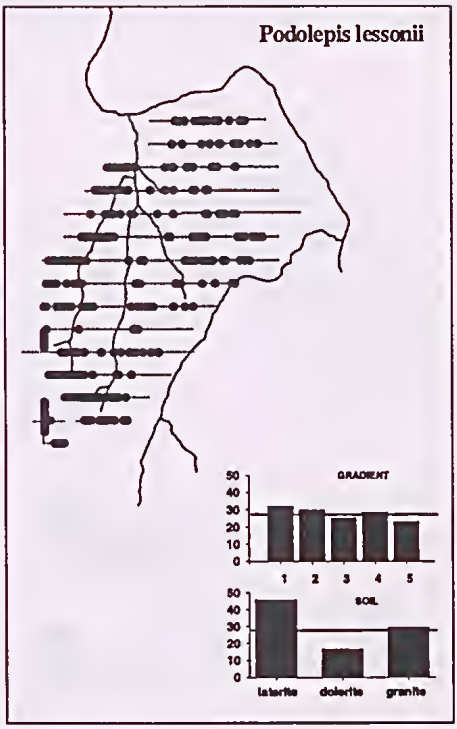
4
5


Hyalosperma cotula
GRADIENT
SOIL
laterite
dolerite
granite

Olearia paucidentata


Podolepis lessonii
GRADIENT
50
40
30
20
10
0
1
2
3
4
5
SOIL
laterite
dolerite
granite

Pterochaeta paniculata
SOIL
25
20
15
10
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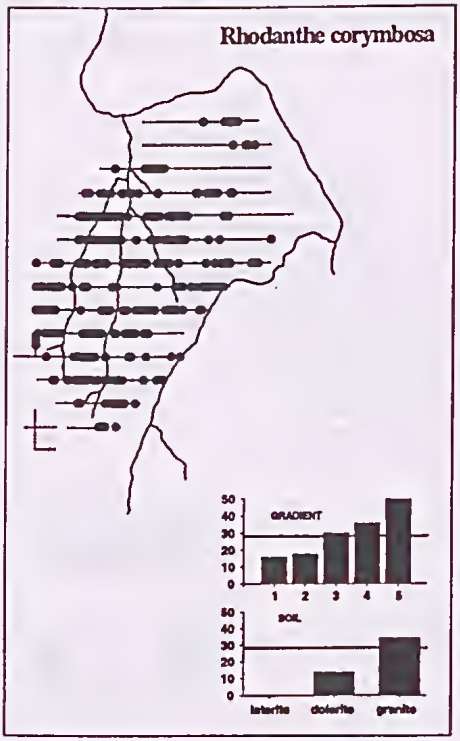
laterite
dolerite
granite

Waitzia suaveolens
SOIL
10
5
0
laterite
dolerite
granite


Rhodanthe corymbosa
GRADIENT
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30
20
10
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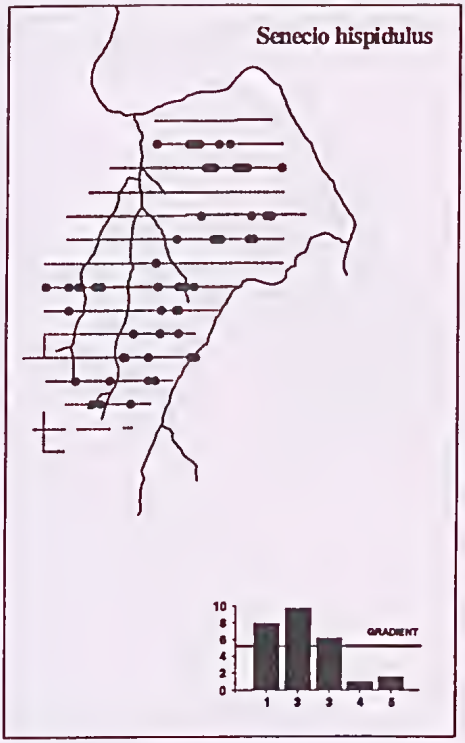
1 2 3 4 5
SOIL
50
40
30
20
10
0
laterite dolerite granite


Senecio hispidulus
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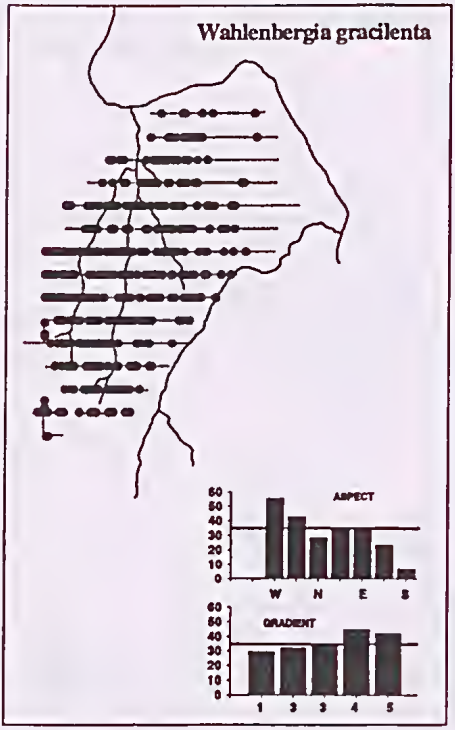
GRADIENT
1 3 3 4 5


Wahlenbergia gracilenta
ASPECT
60
50
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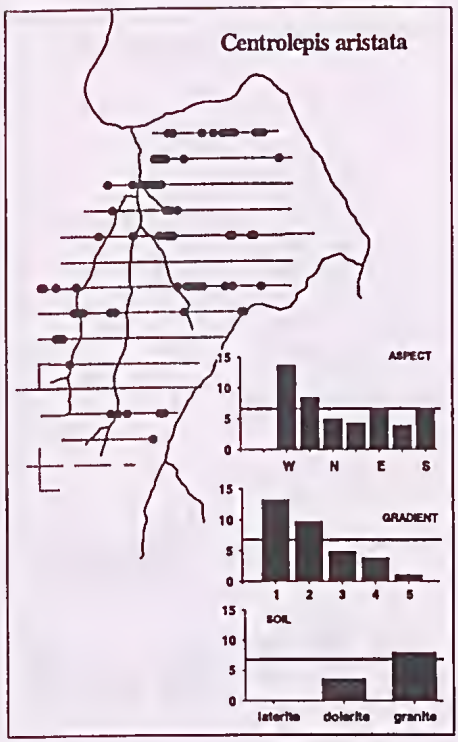
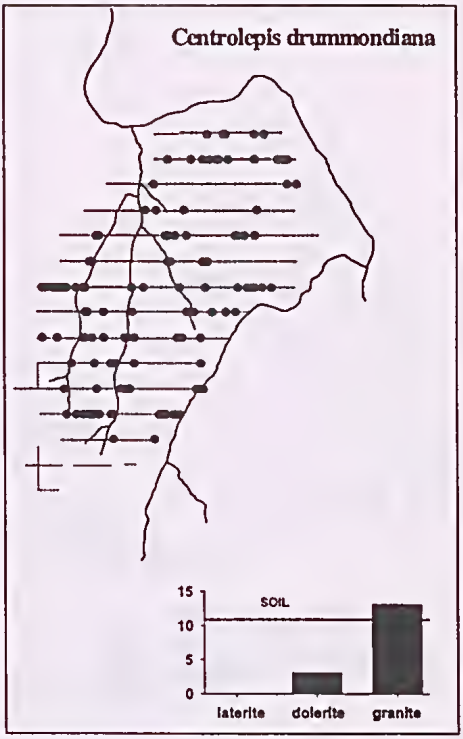
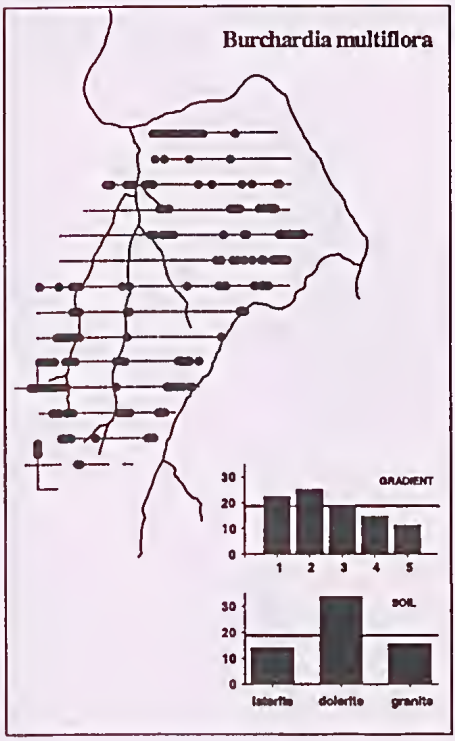
0
W N E S
GRADIENT
60
50
40
30
20
10
0
1 3 3 4 5

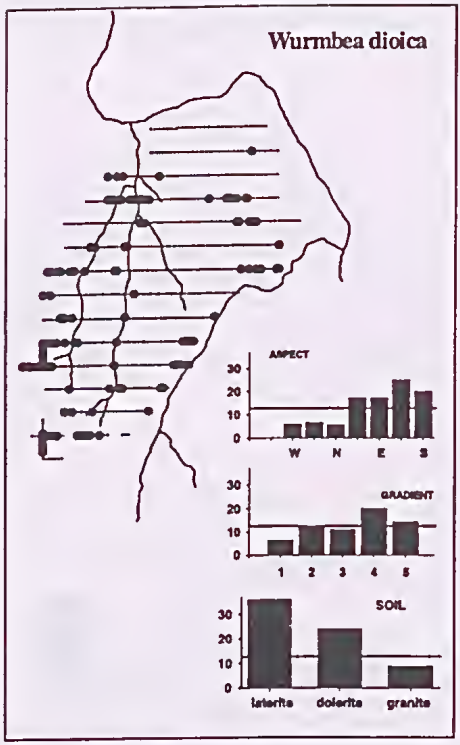
Allocasuarina humilis


Centrolepis aristata
ASPECT
15
10
5
0
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite


Centrolepis drummondiana
SOIL
15
10
5
0
laterite dolerite granite


Burchardia multiflora
GRADIENT
30
20
10
0
1 2 3 4 5
SOIL
laterite dolerite granite

Burchardia umbellata


Wurmbea dioica
ASPECT
30
20
10
0
W
N
E
S
GRADIENT
30
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1
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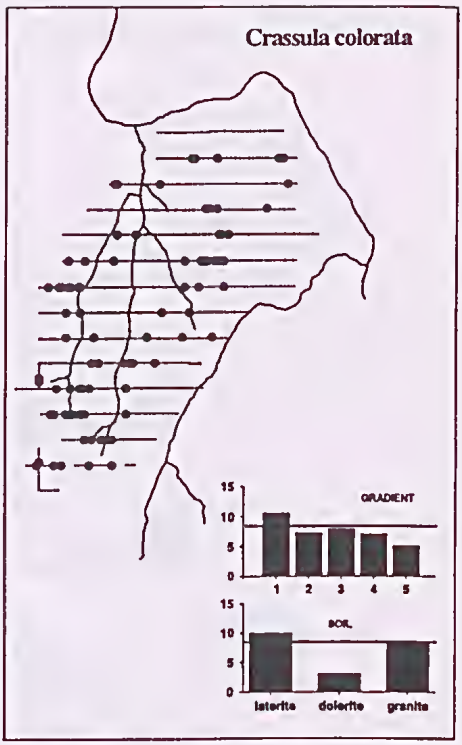
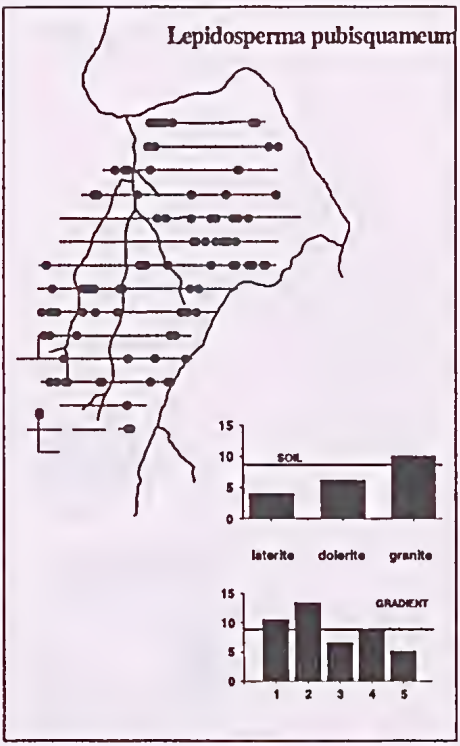
3
4
5
SOIL
30
20
10
0
laterite
dolerite
granite


Crassula colorata
GRADIENT
15
10
5
0
1
2
3
4
5
SOIL
15
10
5
0
laterite
dolerite
granite

Isolepis marginata
SOIL
40
30
20
10
0
laterite
dolerite
granite

Schoenus grammatophyllus

Lepidosperma leptostachyum
SOIL
15
10
5
0
laterite
dolerite
granite


Lepidosperma pubisquameum
SOIL
15
10
5
0
laterite
dolerite
granite
GRADIENT
15
10
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4
5

Lepidosperma tenue
SOIL
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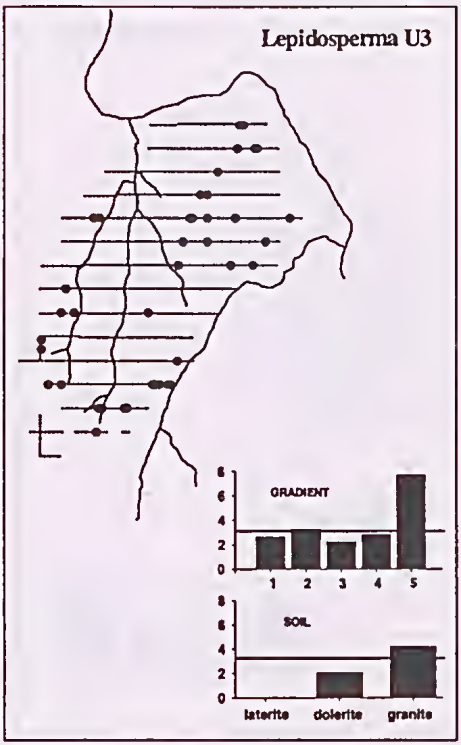
30
20
10
0
laterite
dolerite
granite


Lepidosperma U3
GRADIENT
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6
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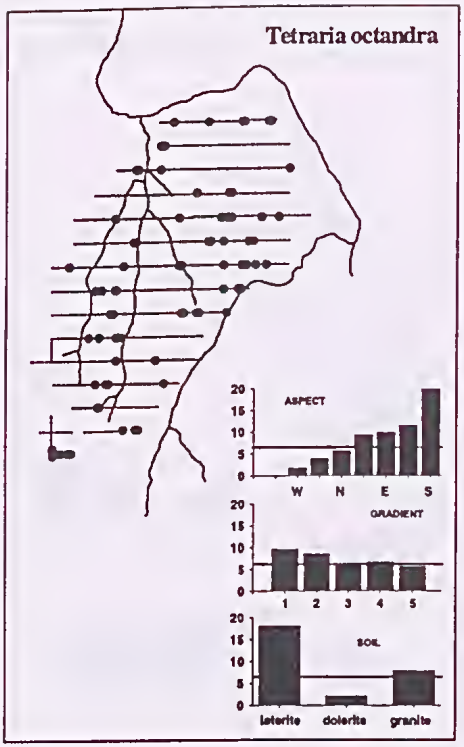
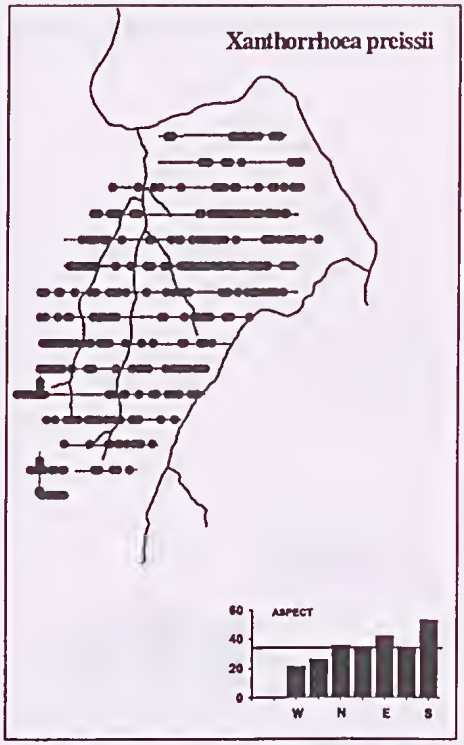
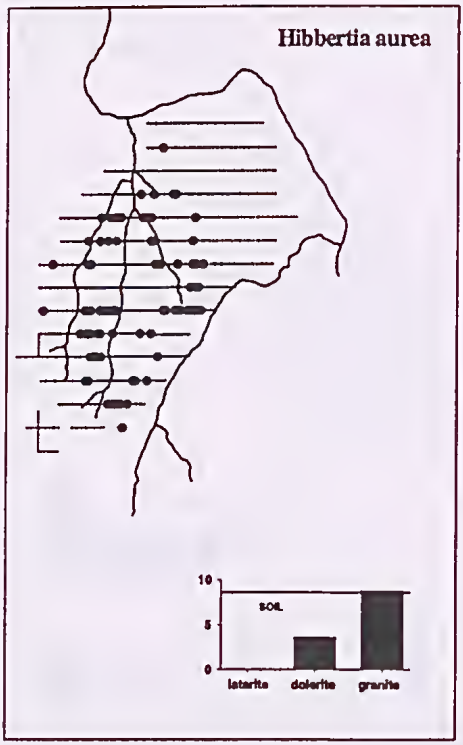
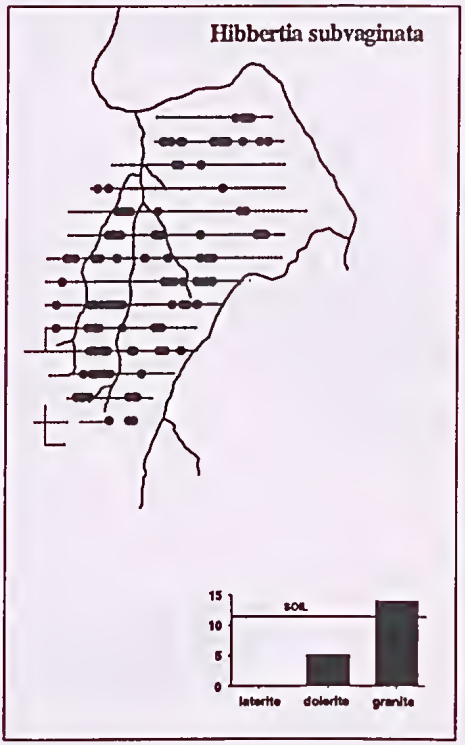
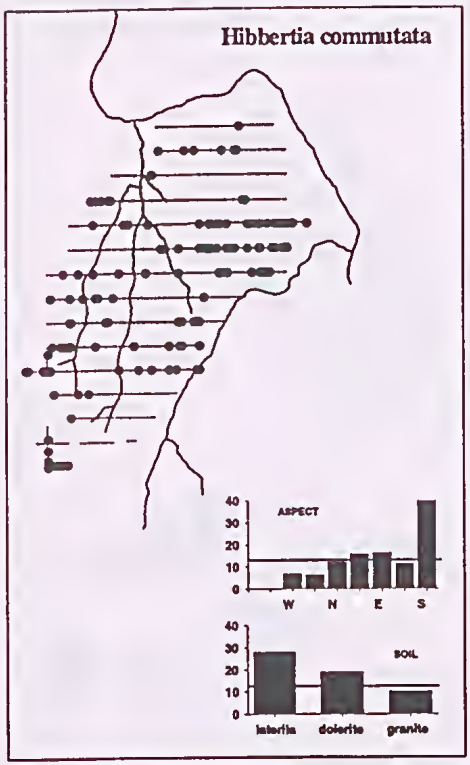
1
2
3
4
5
SOIL
8
6
4
2
0
laterite
dolerite
granite


Tetraria octandra
ASPECT
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite

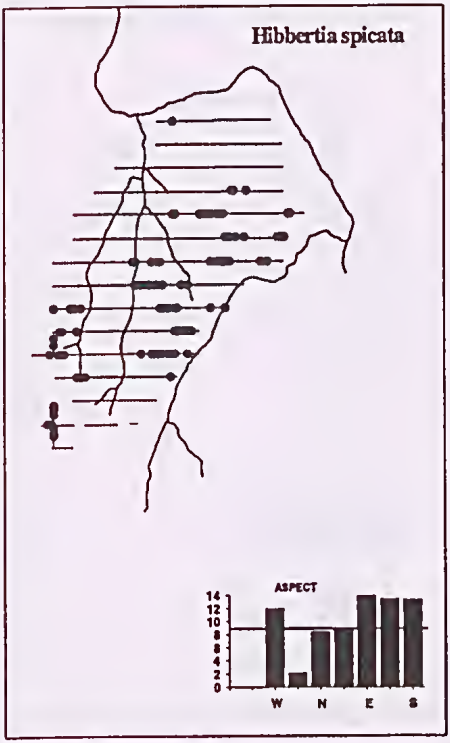

Xanthorrhoea preissii
ASPECT
W N E S


Hibbertia aurea
SOIL
laterite dolerite granite


Hibbertia subvaginata
SOIL
laterite dolerite granite


Hibbertia commutata
ASPECT
40
30
20
10
0
W
N
E
S
SOIL
laterite
dolerite
granite

Hibbertia hypericoides
ASPECT
40
30
20
10
0
W
N
E
S


Hibbertia spicata
ASPECT
14
12
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6
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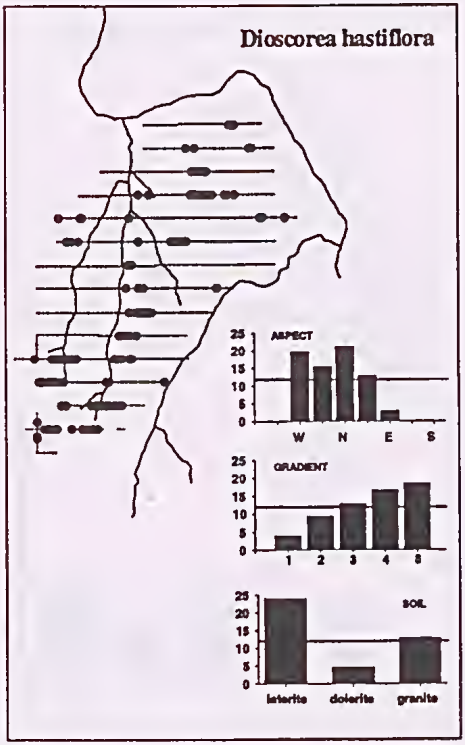
W
N
E
S


Dioscorea hastiflora
ASPECT
25
20
15
10
5
0
W
N
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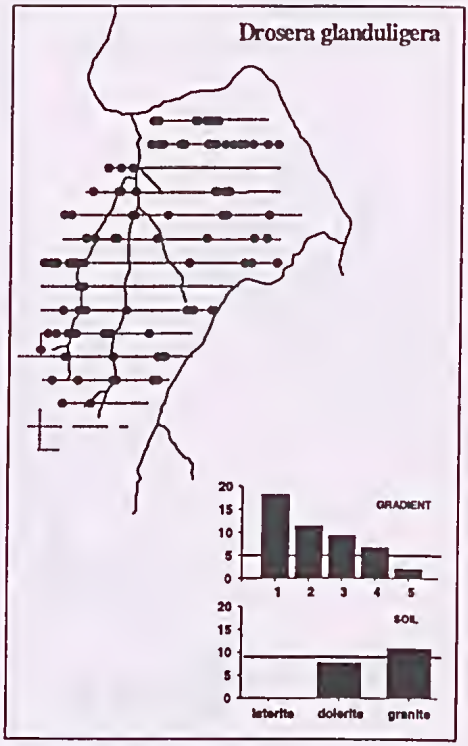
S
GRADIENT
1
2
3
4
5
SOIL
laterite
dolerite
granite

Drosera erythrorrhiza


Drosera glanduligera
GRADIENT
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SOIL
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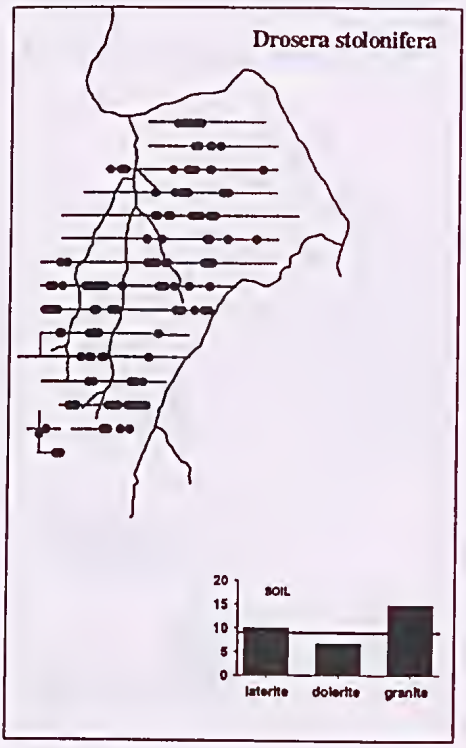
5
0
laterite
dolerite
granite


Drosera stolonifera
SOIL
20
15
10
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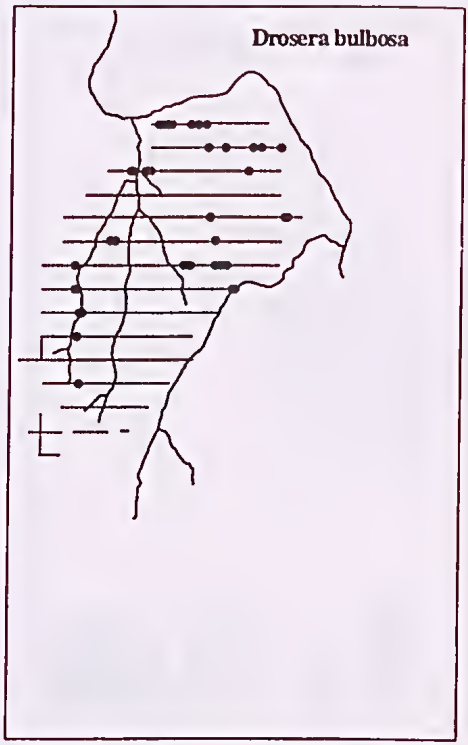
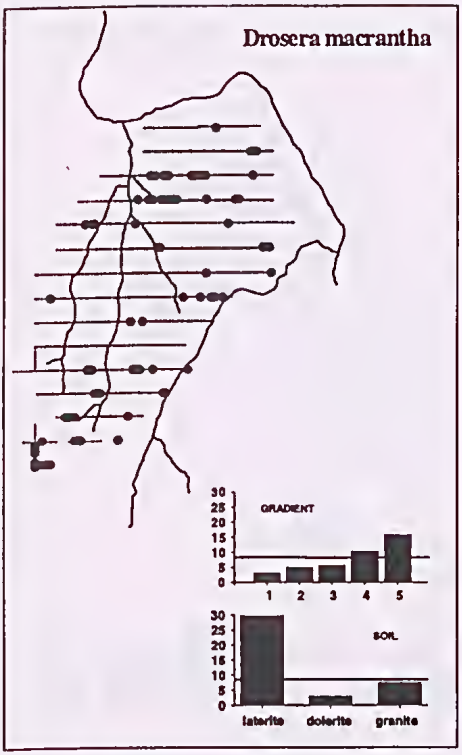
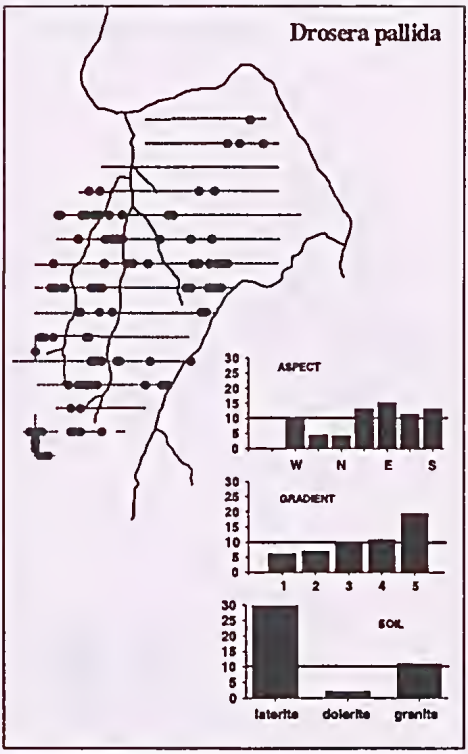
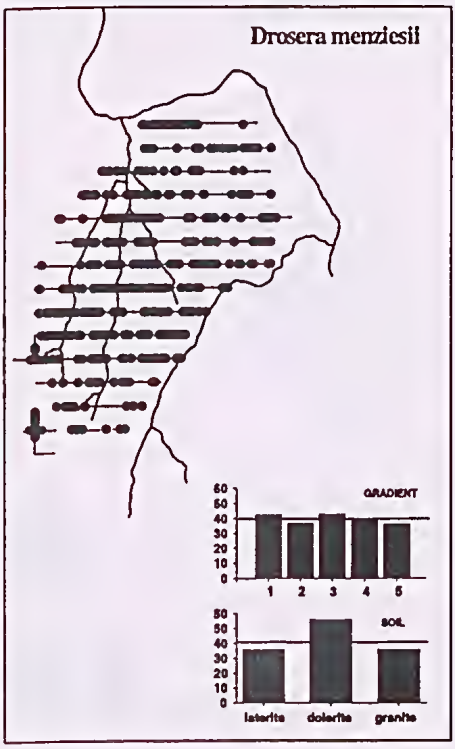
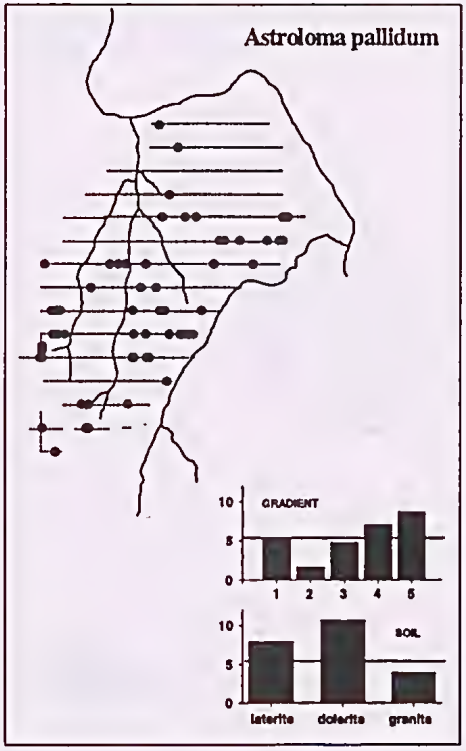
laterite
dolerite
granite


Drosera bulbosa


Drosera macrantha
GRADIENT
SOIL
laterite
dolerite
granite

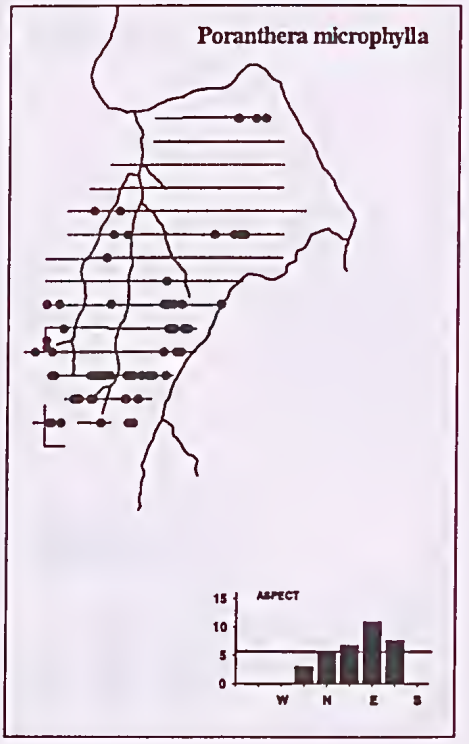

Drosera pallida
ASPECT
W
N
E
S
GRADIENT
SOIL
laterite
dolerite
granite

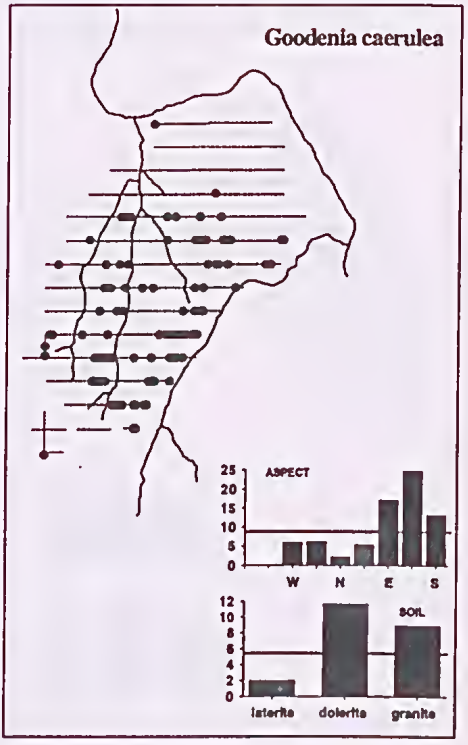

Drosera menziesii
GRADIENT
SOIL
laterite
dolerite
granite

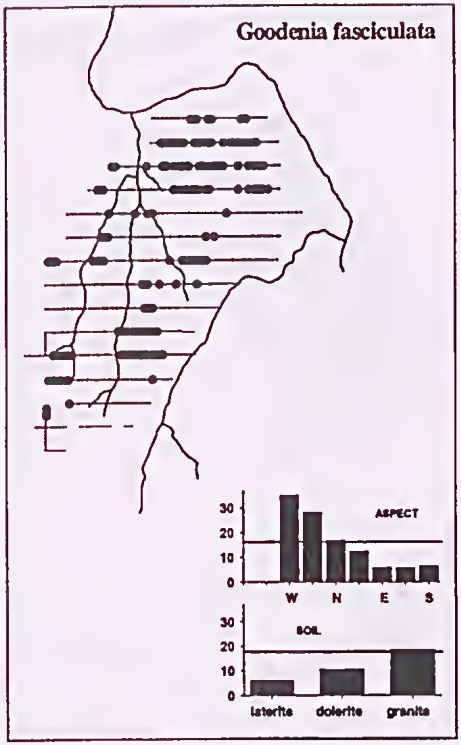

Astroloma pallidum
GRADIENT
SOIL
laterite
dolerite
granite

Leucopogon pulchellus
SOIL
laterite
dolerite
granite

Phyllanthus calycinus
SOIL


Poranthera microphylla
ASPECT
W
N
E
S


Goodenia caerulea
ASPECT
W
N
E
S
SOIL
laterite
dolerite
granite


Goodenia fasciculata
ASPECT
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10
0
W
N
E
S
SOIL
30
20
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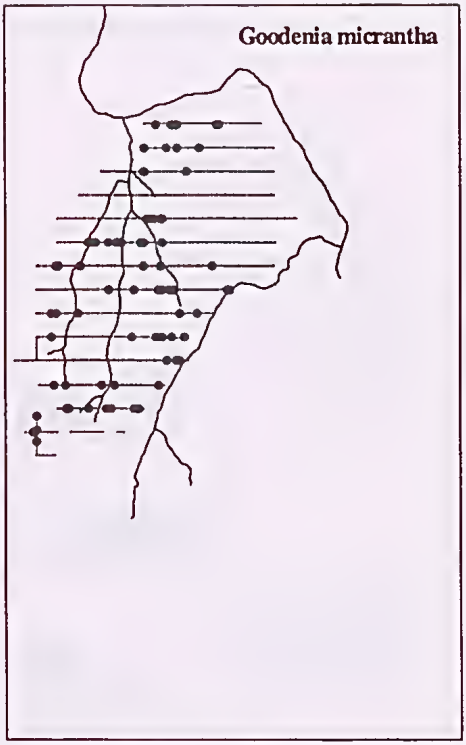
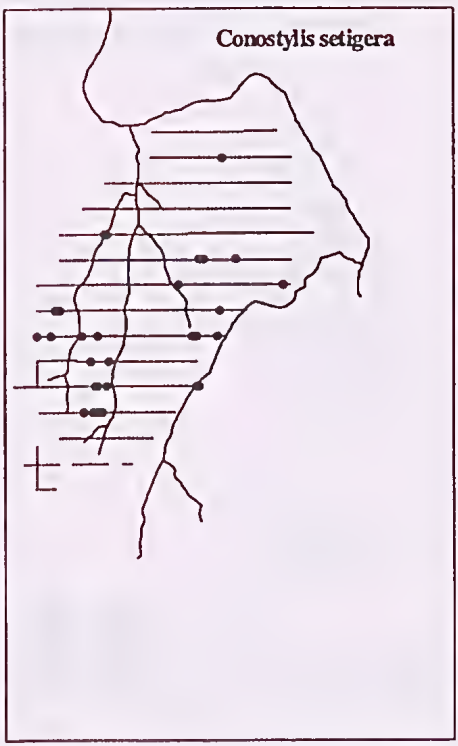
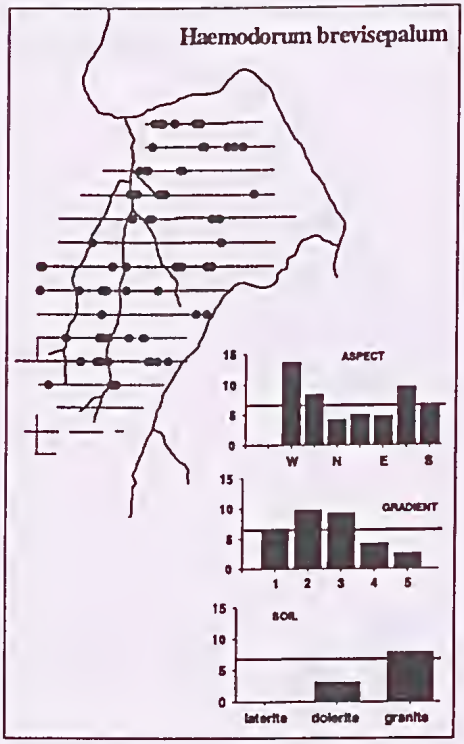
0
laterite
dolerite
granite


Goodenia micrantha


Conostylis setigera

Anigozanthos bicolor


Haemodorum brevisepalum
ASPECT
15
10
5
0
W
N
E
S
GRADIENT
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0
1
2
3
4
5
SOIL
15
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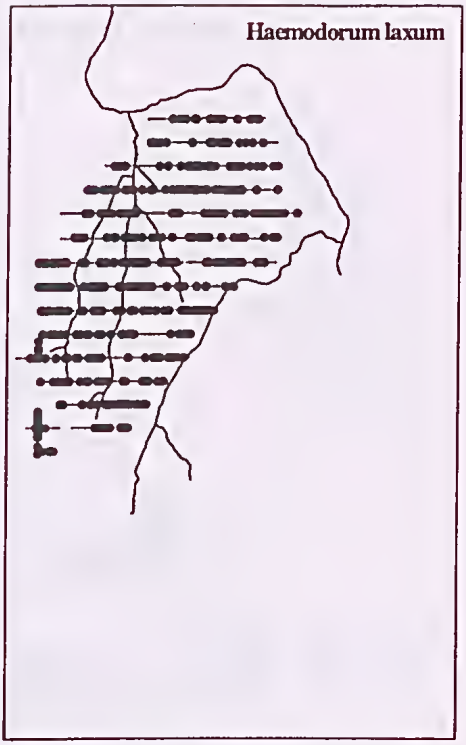
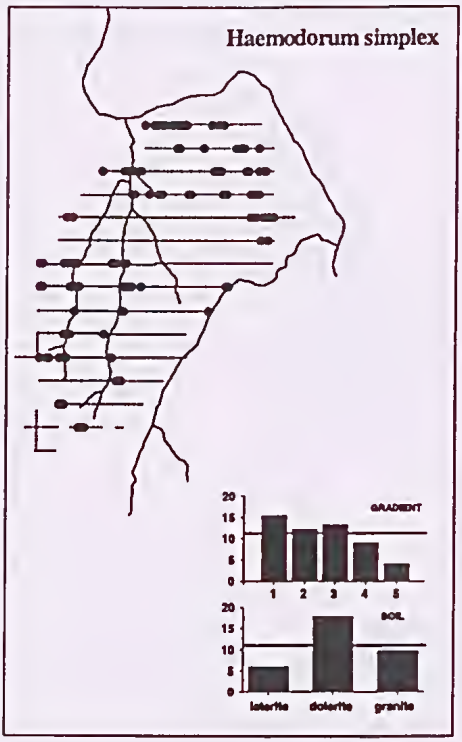
0
laterite
dolerite
granite


Haemodorum laxum


Haemodorum simplex
GRADIENT
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SOIL
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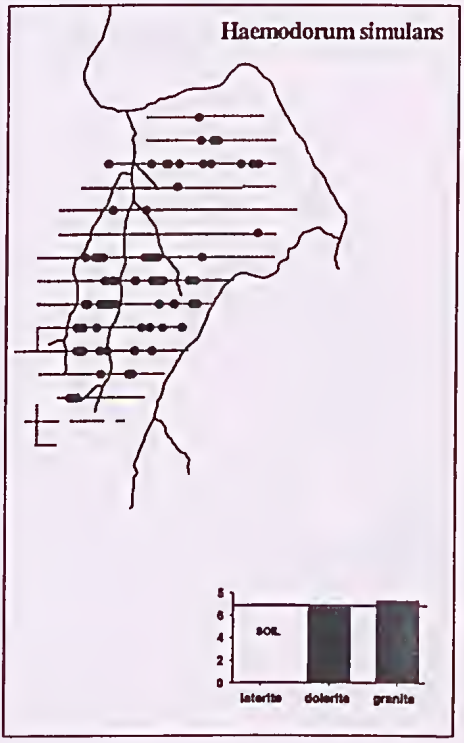
0
laterite
dolerite
granite


Haemodorum simulans
SOIL
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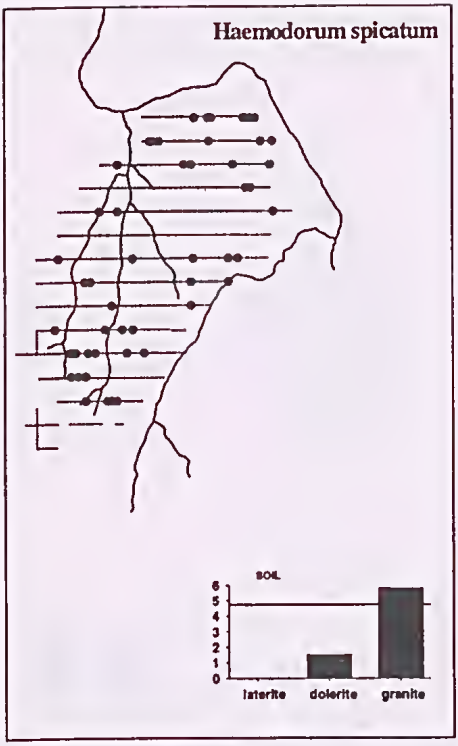
6
4
2
0
laterite
dolerite
granite


Haemodorum spicatum
SOIL
6
5
4
3
2
1
0
laterite
dolerite
granite

Tribonanthes brachypetala
GRADIENT
20
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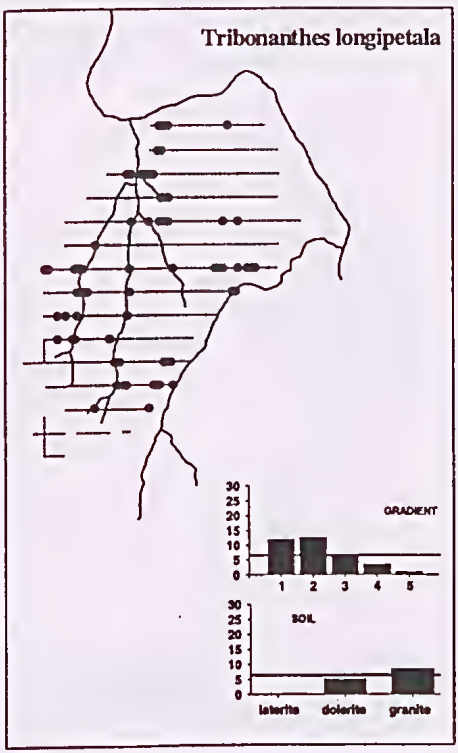
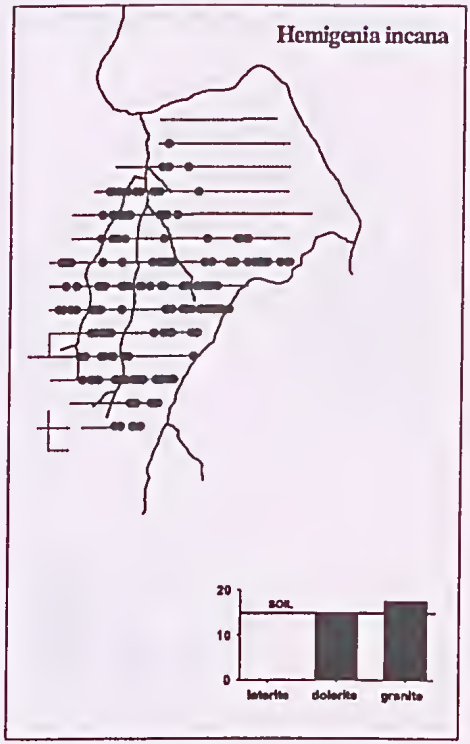
4
5

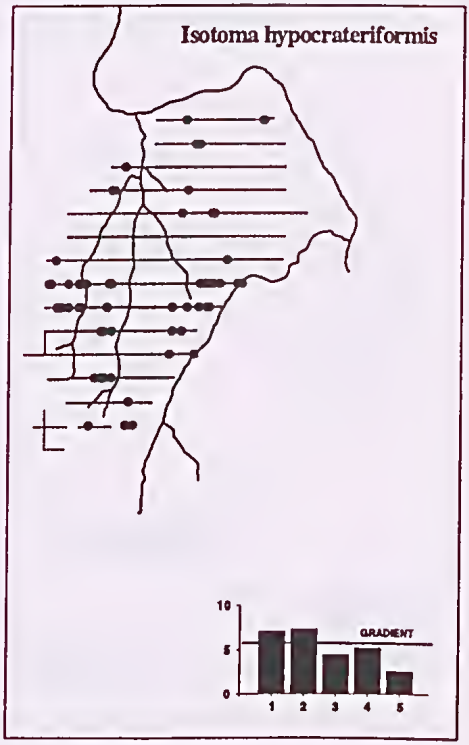

Tribonanthes longipetala
GRADIENT
30
25
20
15
10
5
0
1
2
3
4
5
SOIL
30
25
20
15
10
5
0
laterite
dolerite
granite

Gonocarpus cordiger

Hypoxis occidentalis

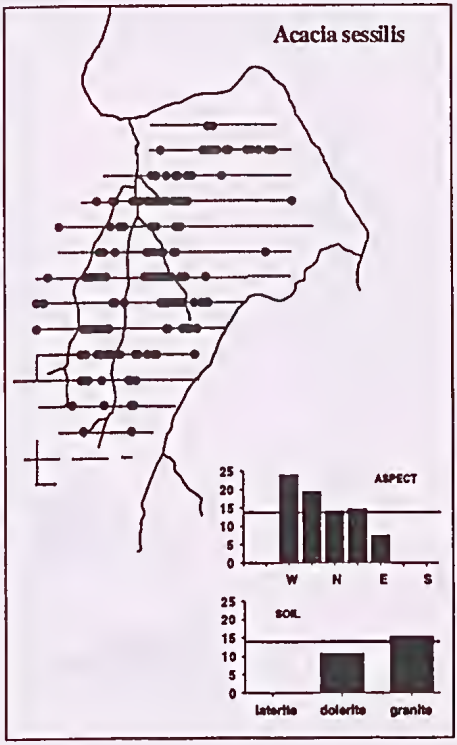

Hemigenia incana
SOIL
20
10
0
laterite
dolerite
granite

Cassytha pomiformis

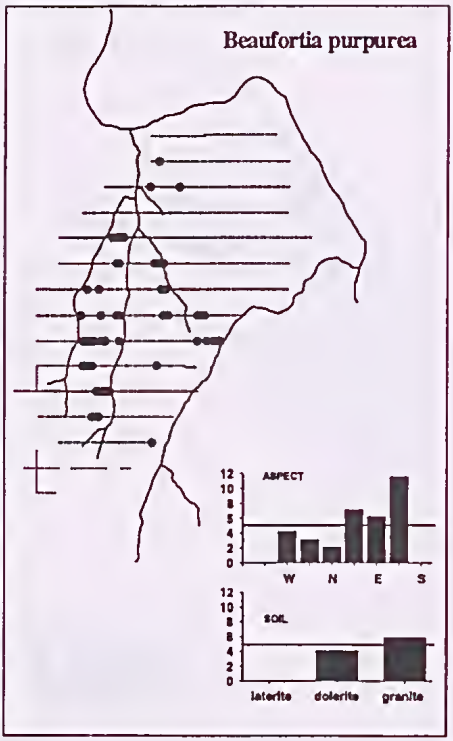

Isotoma hypocrateriformis
10
5
0
GRADIENT
1
2
3
4
5

Lobelia rhytidosperma

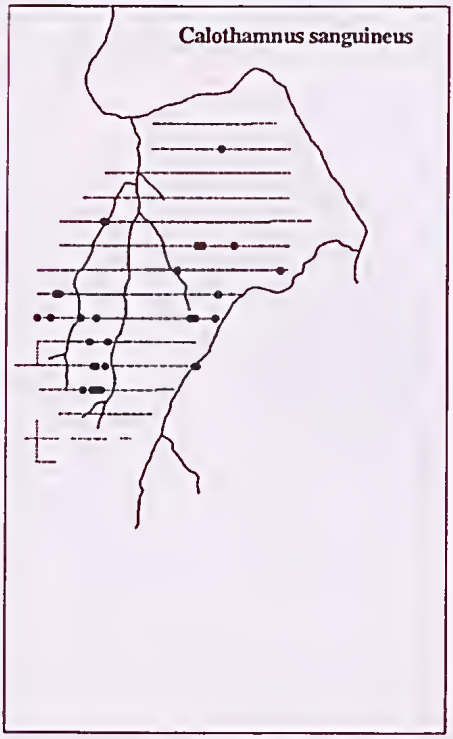
Acacia pulchella
ASPECT
100
80
60
40
20
0
W
N
E
S

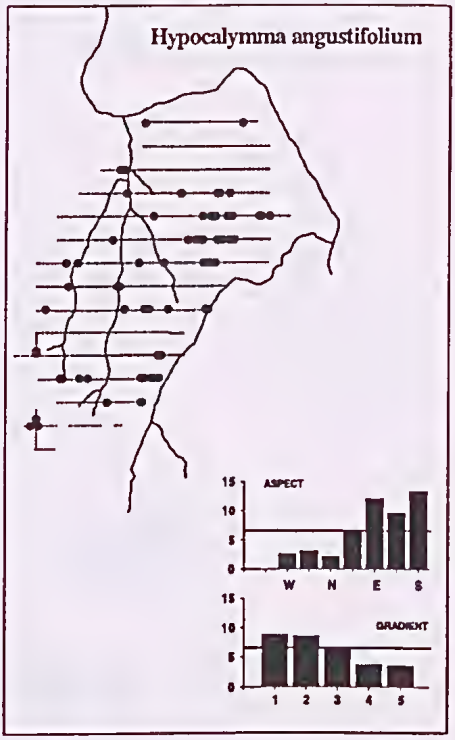

Acacia sessilis
ASPECT
25
20
15
10
5
0
W
N
E
S
SOIL
laterite
dolerite
granite

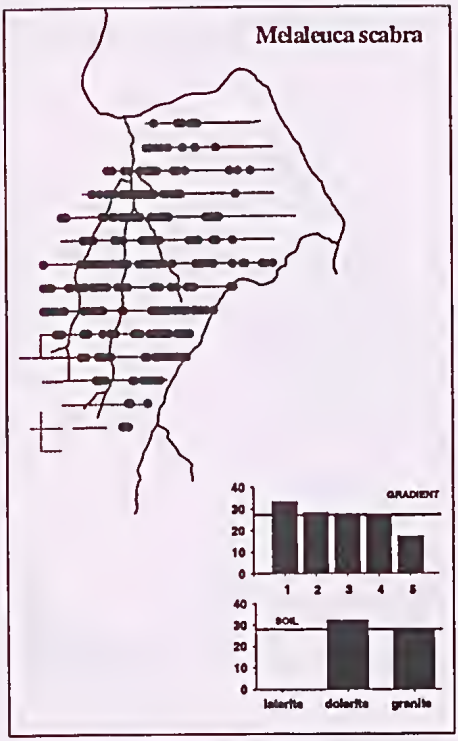
Baeckia camphorosmae

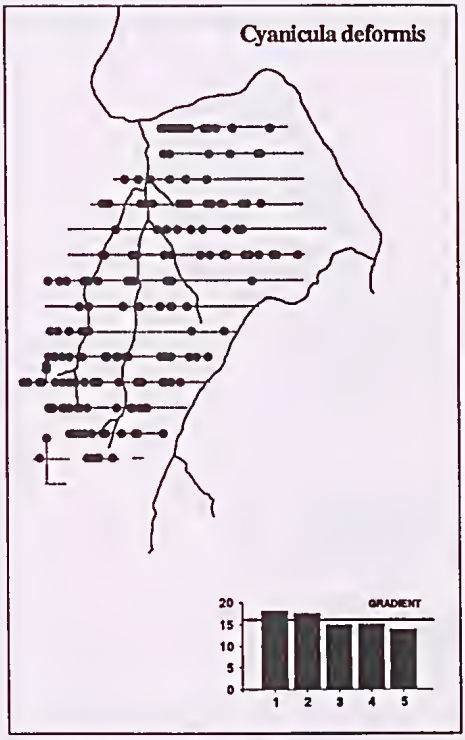

Beaufortia purpurea
ASPECT
12
10
8
6
4
2
0
W
N
E
S
SOIL
laterite
dolerite
granite

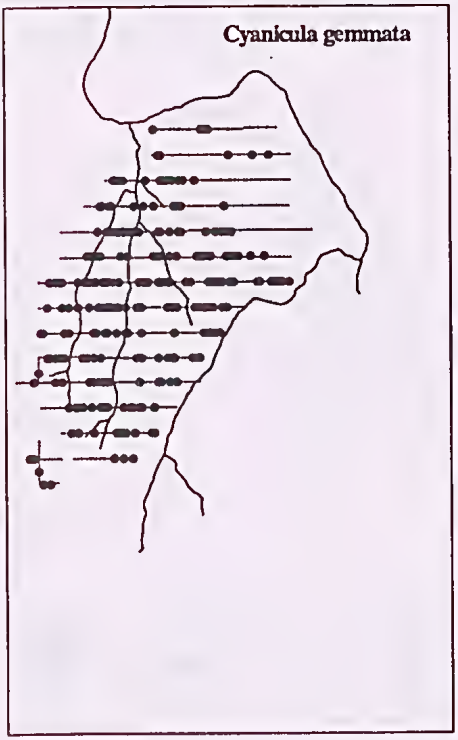
Calothamnus quadrifidus
SOIL
60
40
20
0
laterite
dolerite
granite

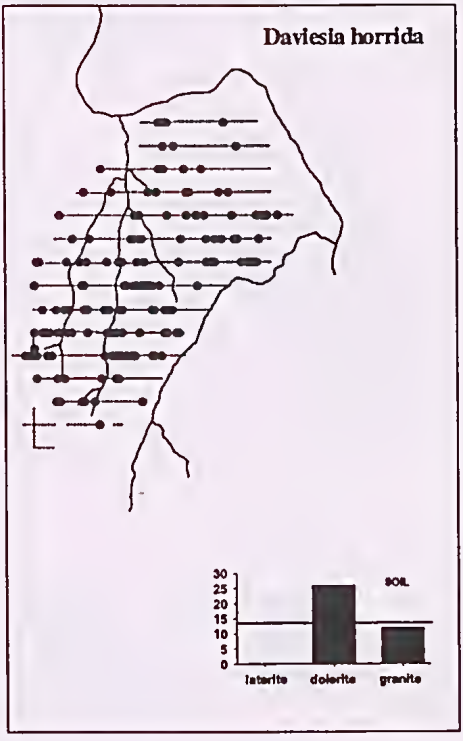

Calothamnus sanguineus


Hypocalymma angustifolium
ASPECT
15
10
5
0
W
N
E
S
GRADIENT
1
2
3
4
5

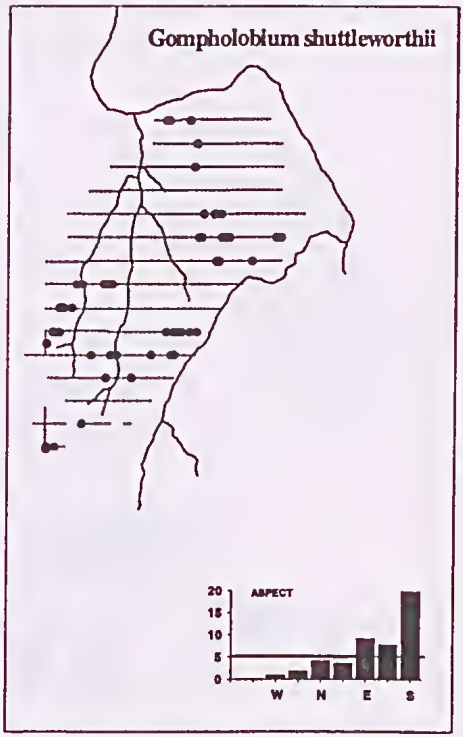

Melaleuca scabra
GRADIENT
40
30
20
10
0
1 2 3 4 5
SOIL
40
30
20
10
0
laterite
dolerite
granite

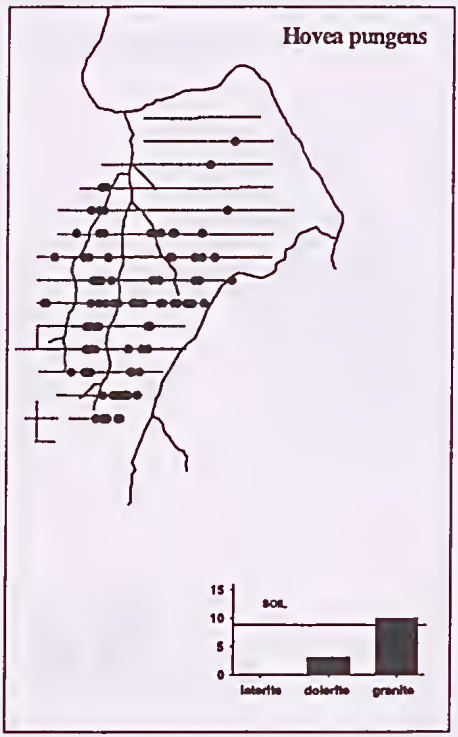

Cyanicula deformis
GRADIENT
20
15
10
5
0
1 2 3 4 5

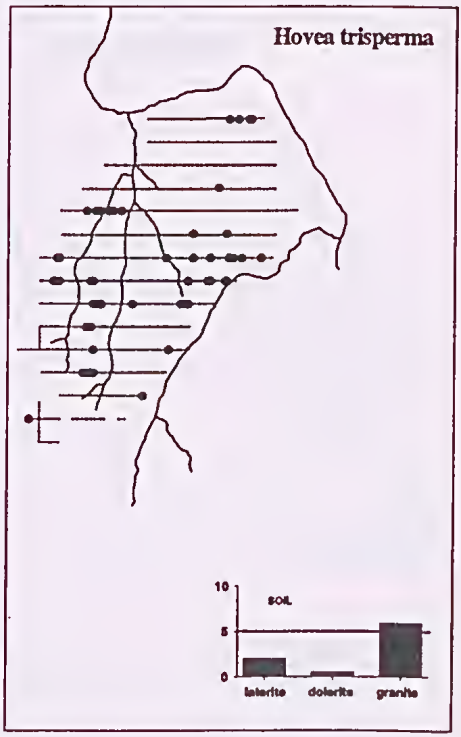

Cyanicula gemmata


Daviesia horrida
SOIL
30
25
20
15
10
5
0
laterite
dolerite
granite

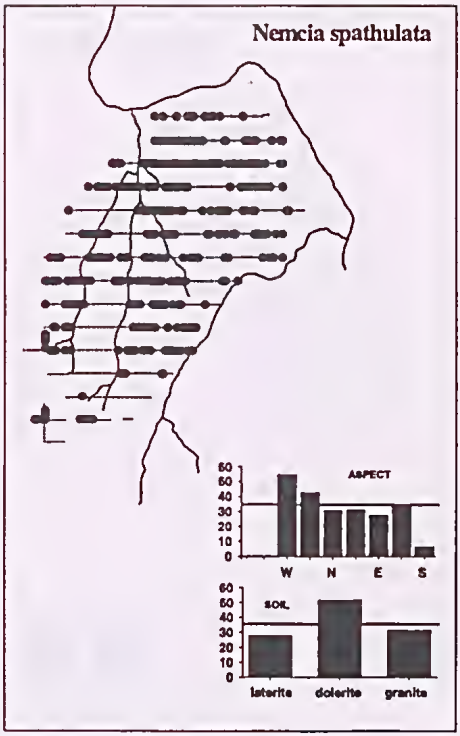
Gompholobium marginatum

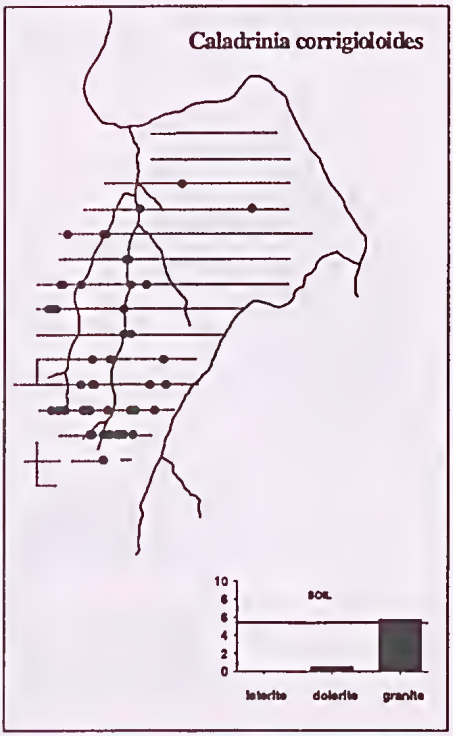

Gompholobium shuttleworthii
ASPECT
20
15
10
5
0
W
N
E
S

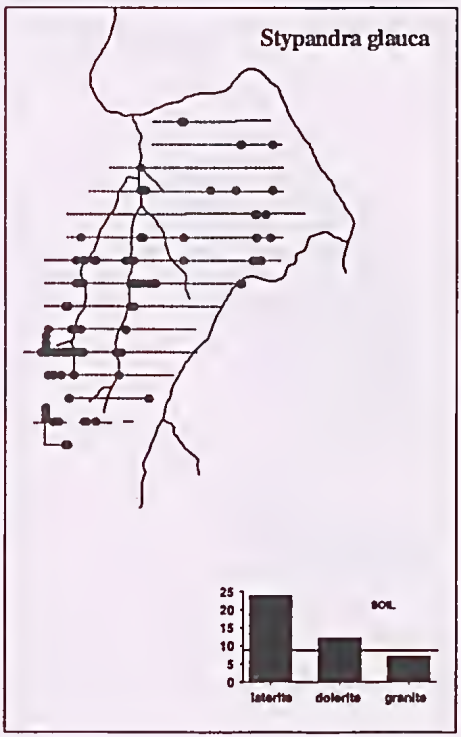

Hovea pungens
SOIL
15
10
5
0
laterite
dolerite
granite


Hovea trisperma
SOIL
10
5
0
laterite
dolerite
granite

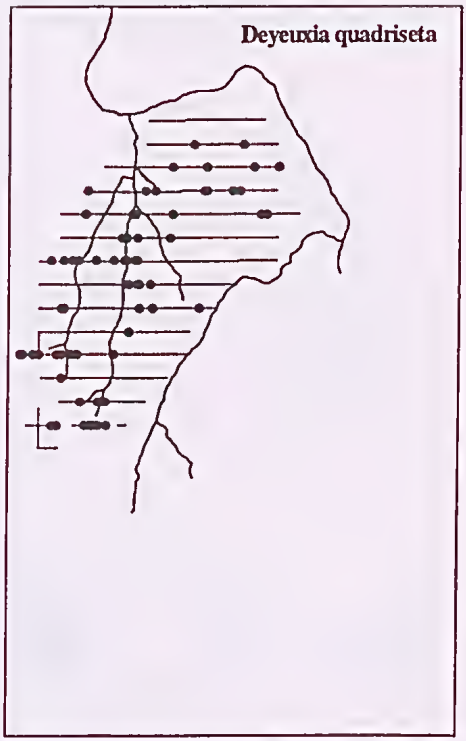
Isotropis cuneifolia
SOIL
laterite
dolerite
granite

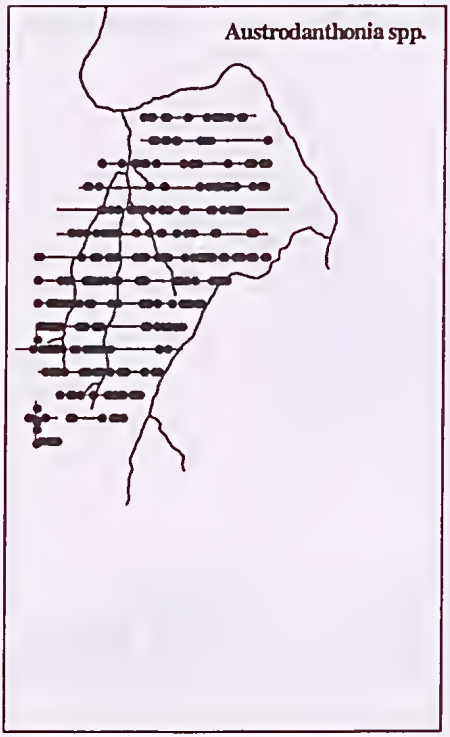

Nemcia spathulata
ASPECT
W
N
E
S
SOIL
laterite
dolerite
granite

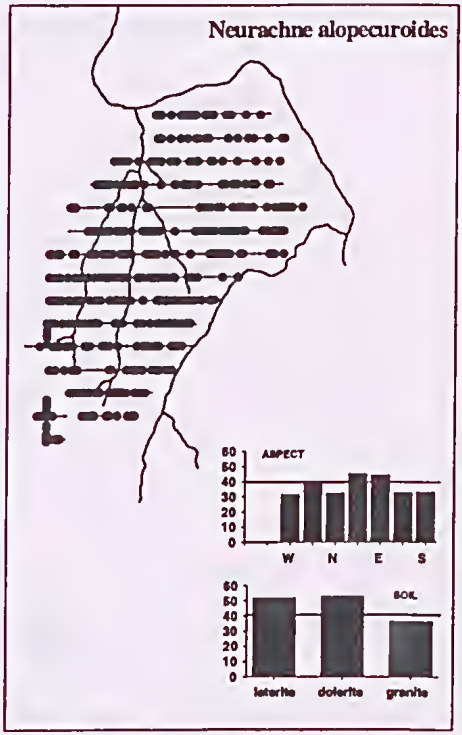

Caladrinia corrigioloides
SOIL
laterite
dolerite
granite

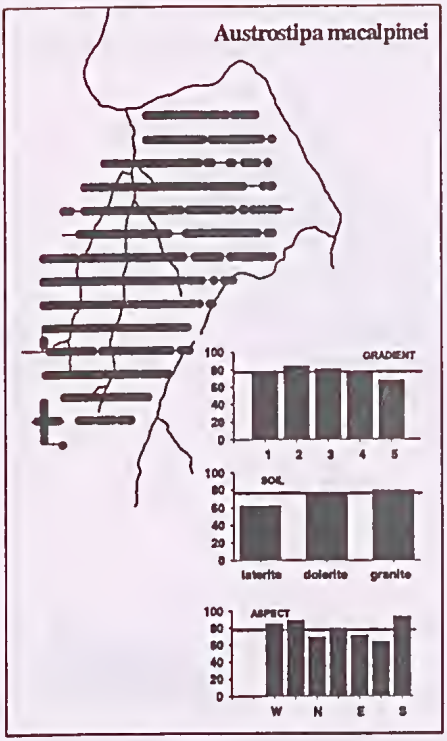

Stypandra glauca
SOIL
laterite
dolerite
granite

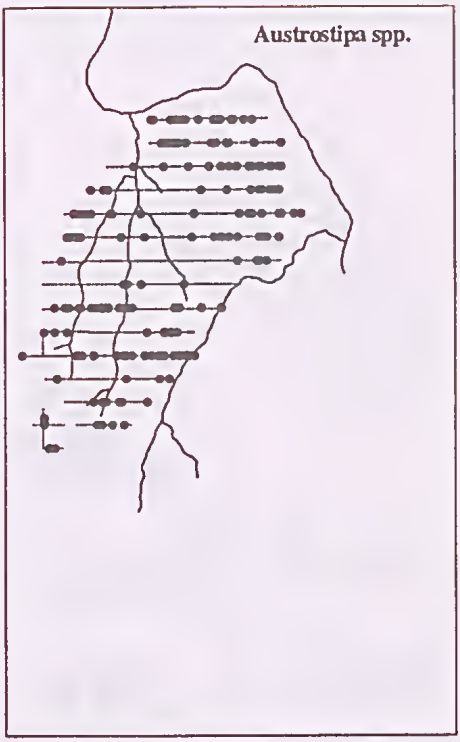
Amphipogon strictus
SOIL
20
15
10
5
0
laterite
dolerite
granite


Deyeuxia quadriseta

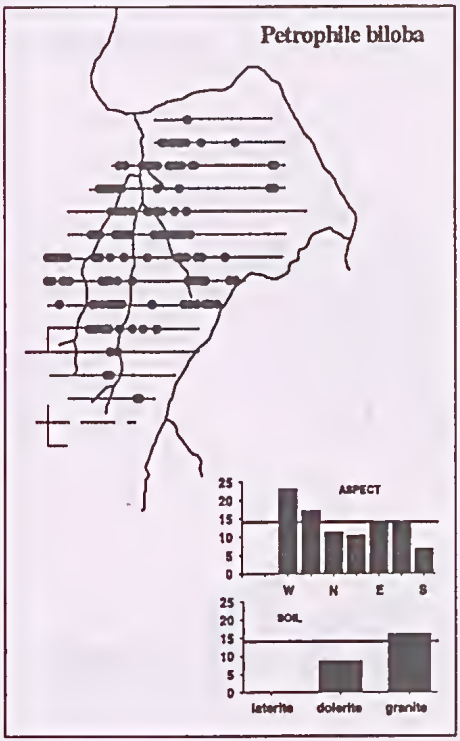

Austrodanthonia spp.

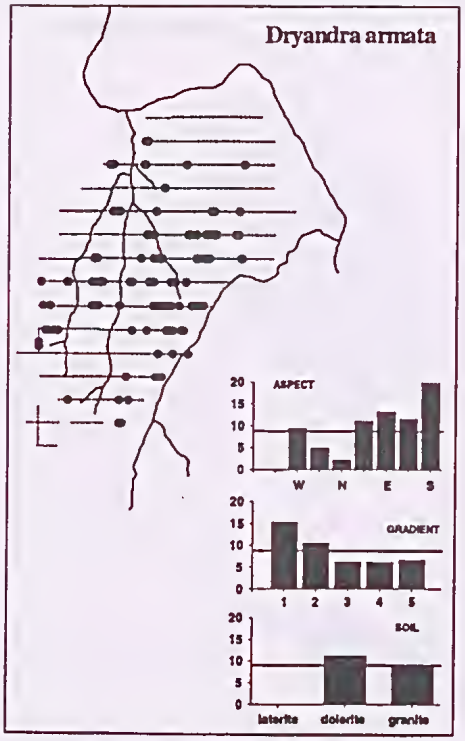

Neurachne alopecuroides
ASPECT
60
50
40
30
20
10
0
W
N
E
S
SOIL
laterite
dolerite
granite


Austrostipa macalpinei
GRADIENT
100
80
60
40
20
0
1 2 3 4 5
SOIL
laterite dolerite granite
ASPECT
W N E S


Austrostipa spp.

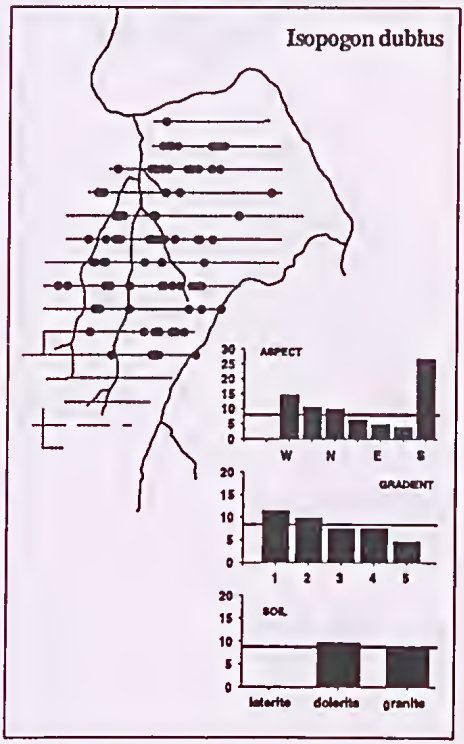
Conospermum huegelii


Petrophile biloba
ASPECT
25
20
15
10
5
0
W N E S
SOIL
laterite dolerite granite

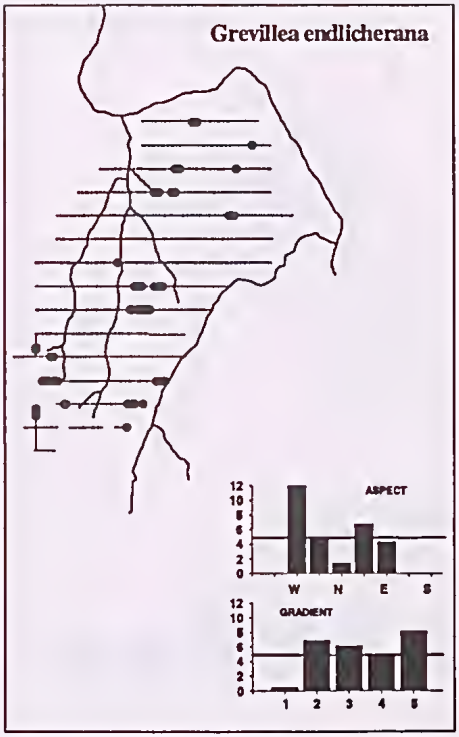

Dryandra armata
ASPECT
20
15
10
5
0
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite

Dryandra nivea
ASPECT
40
30
20
10
0
W N E S

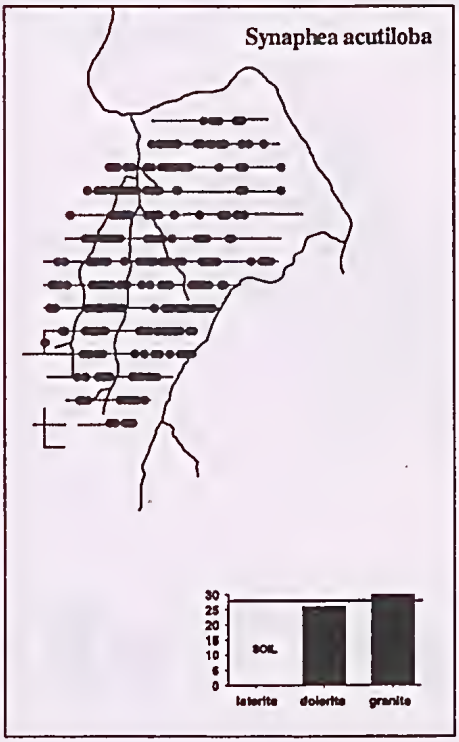
Hakea incrassata
30
25
20
15
10
5
0
SOIL
laterite dolerite granite

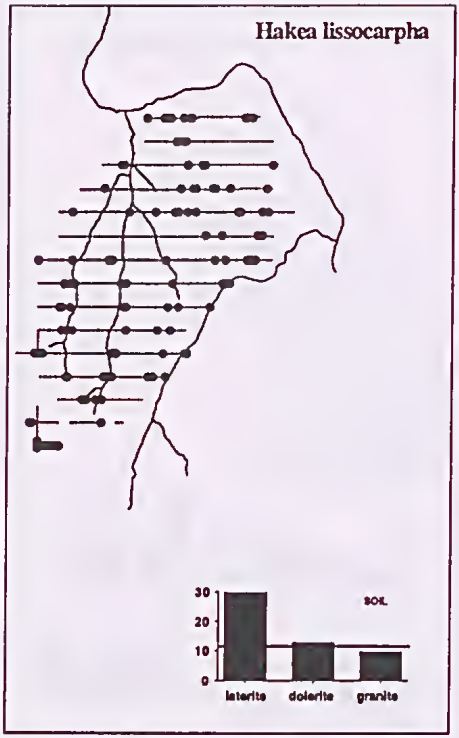

Isopogon dubius
ASPECT
30
25
20
15
10
5
0
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite

Grevillea bipinnatafida

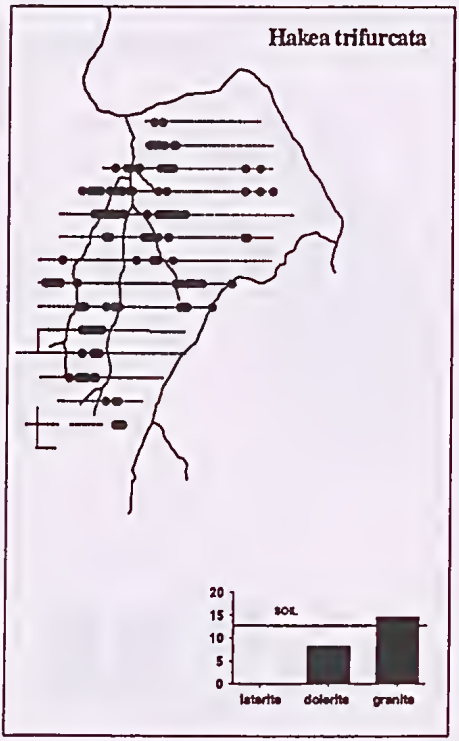

Grevillea endlicherana
ASPECT
12
10
8
6
4
2
0
W
N
E
S
GRADIENT
12
10
8
6
4
2
0
1
2
3
4
5

Grevillea pilulifera

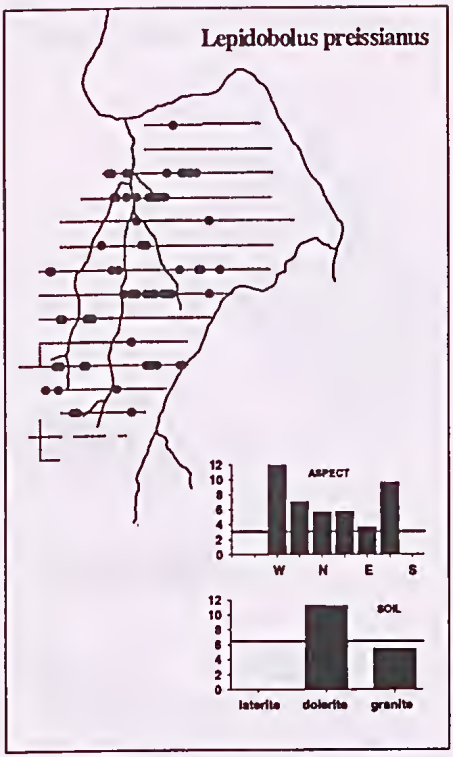

Synaphea acutiloba
30
25
20
15
10
5
0
SOIL
laterite
dolerite
granite

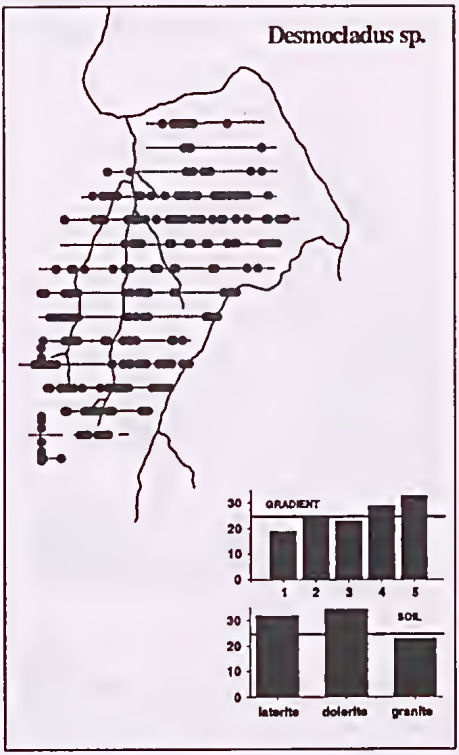

Hakea lissocarpha
30
20
10
0
SOIL
laterite
dolerite
granite

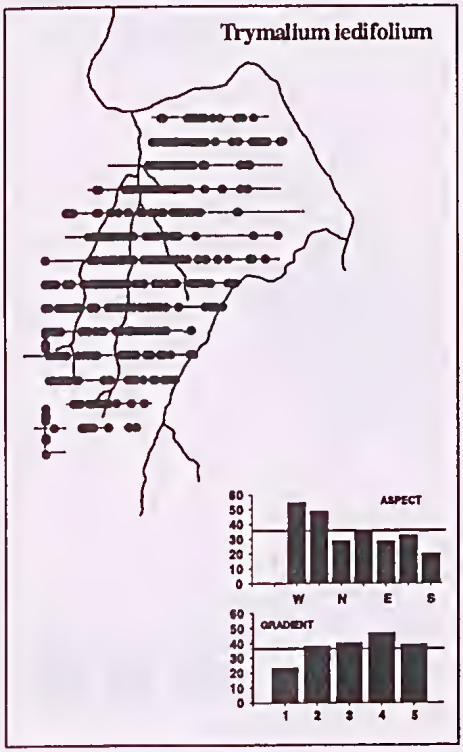
Hakea erinacea
15
10
5
0
SOIL
laterite
dolerite
granite

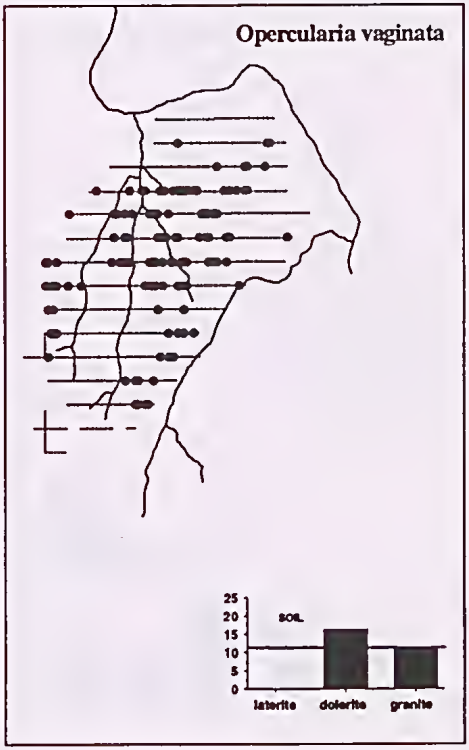

Hakea trifurcata
20
15
10
5
0
SOIL
laterite
dolerite
granite

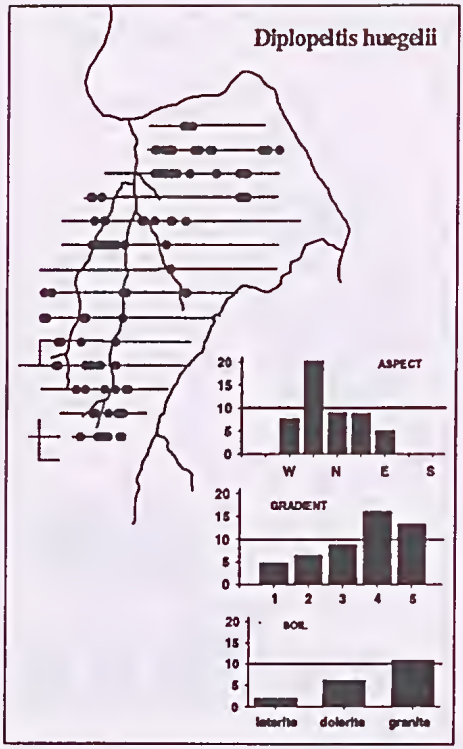
Hakea undulata
15
10
5
0
SOIL
laterite
dolerite
granite

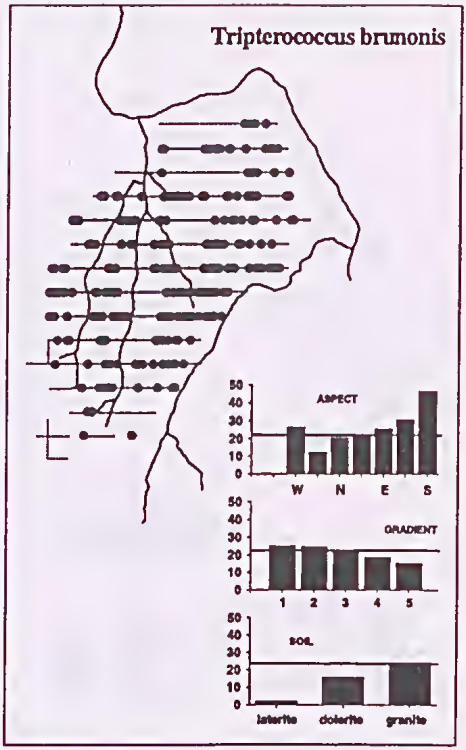

Lepidobolus preissianus
ASPECT
W N E S
SOIL
laterite dolerite granite

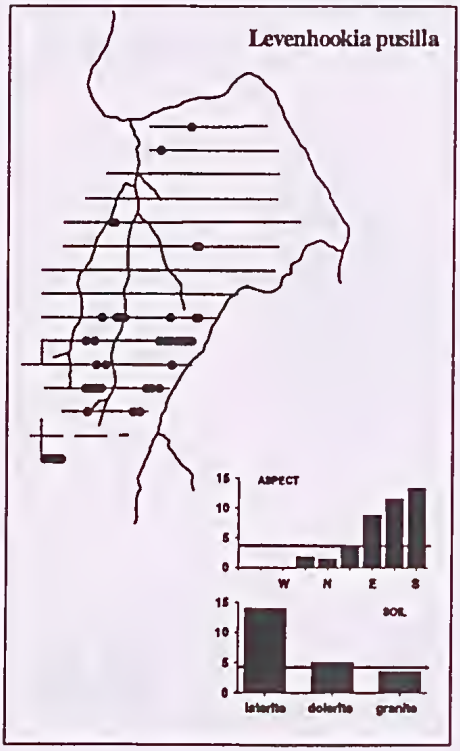

Desmocladus sp.
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite


Trymalium iedifolium
ASPECT
W N E S
GRADIENT
1 2 3 4 5

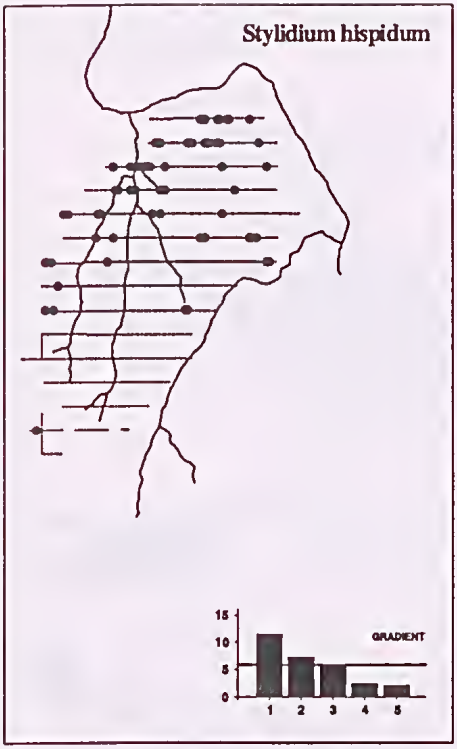

Opercularia vaginata
SOIL
laterite dolerite granite


Diplopeltis huegelii
ASPECT
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite


Tripterococcus brunonis
ASPECT
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite


Levenhookia pusilla
ASPECT
W N E S
SOIL
laterite dolerite granite

Levenhookia stipitata
SOIL
laterite dolerite granite


Stylidium hispidum
GRADIENT
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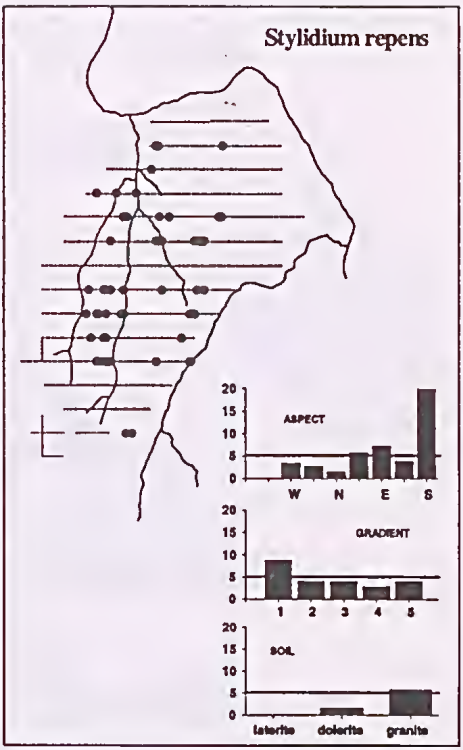
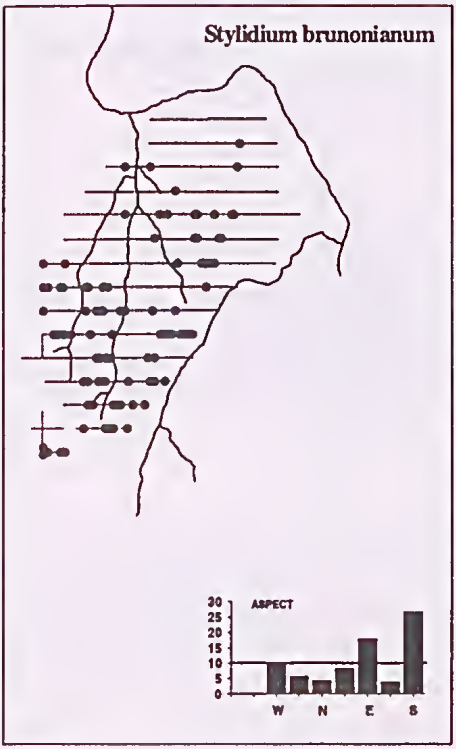
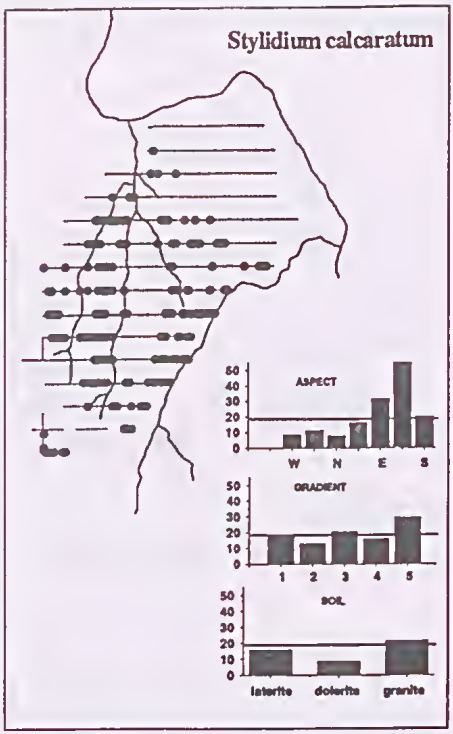
5
0
1 2 3 4 5


Stylidium repens
ASPECT
20
15
10
5
0
W N E S
GRADIENT
1 2 3 4 5
SOIL
laterite dolerite granite


Stylidium brunonianum
ASPECT
30
25
20
15
10
5
0
W N E S

Stylidium bulbiferum
ASPECT
30
20
10
0
W N E S


Stylidium calcaratum
ASPECT
60
40
30
20
10
0
W
N
E
S
GRADIENT
50
40
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10
0
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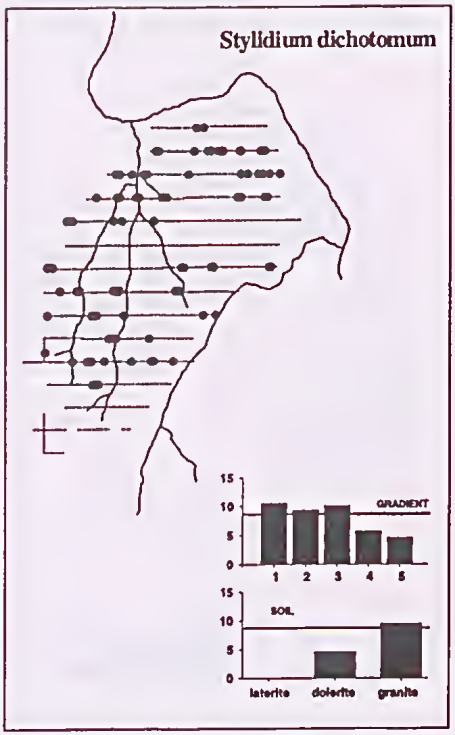
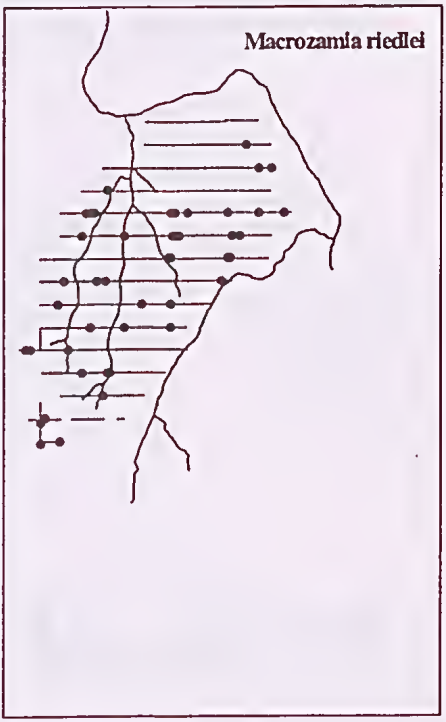
3
4
5
SOIL
50
40
30
20
10
0
laterite
dolerite
granite


Stylidium dichotomum
GRADIENT
15
10
5
0
1
2
3
4
5
SOIL
15
10
5
0
laterite
dolerite
granite

Pimelia imbricata
SOIL
20
15
10
5
0
laterite
dolerite
granite


Macrozamia riedlei

51087

CLUB NEWS

Programme

General Meetings and Branch Meetings are held at various venues in Nedlands, Kalamunda, Rockingham and Padbury.
The Retired and Leisured Group meets on alternate Wednesdays at 10a.m.
Excursions and field days are planned from time to time and will be advertised in the Club's monthly newsletter "The Naturalist News".

THE WESTERN AUSTRALIAN NATURALIST

(Journal of the W.A. Naturalists' Club)

Editor
MR JOHN DELL

The Western Australian Naturalist publishes original data on all branches of natural science pertaining to Western Australia. Originals and two copies of manuscripts should be submitted to the Editor for review by two referees. Authors are requested to follow current editorial style. If possible, manuscripts should be submitted on an IBM compatible 5¼ disk in either ASCII or Microsoft Word v3 format. High quality illustrations suitable for some reductions in size are preferred.

DONATIONS TO THE CLUB

Members are reminded that they may make financial contributions to the club. This funding is very important from the Club's point of view, as it helps our publication activities, hall maintenance and other miscellaneous activities. Members are asked to remember the club and its needs when preparing their Wills and Testaments.

SUBSCRIPTIONS

Annual Membership: one adult, $47; Double Membership: $58; Family Membership: $58; Nomination Fee (Seniors only): $5; Preceding Subscriptions include "The Western Australian Naturalist". Young members (9–17 years): $24.
Further copies of "The Western Australian Naturalist" (or back copies) are available from the Treasurer

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HANDBOOKS

The Club's Handbooks are for sale

No. 2 Natural History Specimens: Their Collection and Preservation 5th Edition. Price $4.40

No. 7 The Dragonflies (Odonata) of South-western Australia. By J. A. L. Watson. Price $3.85

No. 10 A Guide to the Coastal Flora of South-western Australia. By G. G. Smith 2nd Edition. Price $8.80

No. 11 The Natural History of the Wongan Hills. K. F. Kenneally (Co-ordinator). Price $6.60

No. 12 Mangroves of Western Australia. By V. Semeniuk, K. F. Kenneally and P. G. Wilson. Price $6.60

No. 13 A Naturalists' Guide to Perth. By B. M. J. Hussey, M. Southwell-Keely and J. M. Start. Price $11.00

No. 14 Checklist of the Vascular Plants of the Kimberley, Western Australia. By Kevin Kenneally. Price $8.80

No. 15 Pollination in Western Australia – a Database of Animals Visiting Flowers. By E. M. Brown, A. H. Burbidge, J. Dell, D. Edinger, S.D. Hopper and R. T. Wills Price $27.50

Growing Locals: Gardening with Local Plants in Perth. By R. Powell and J. Emberson. Price $21.45

* Prices shown do not include postage and packaging *

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